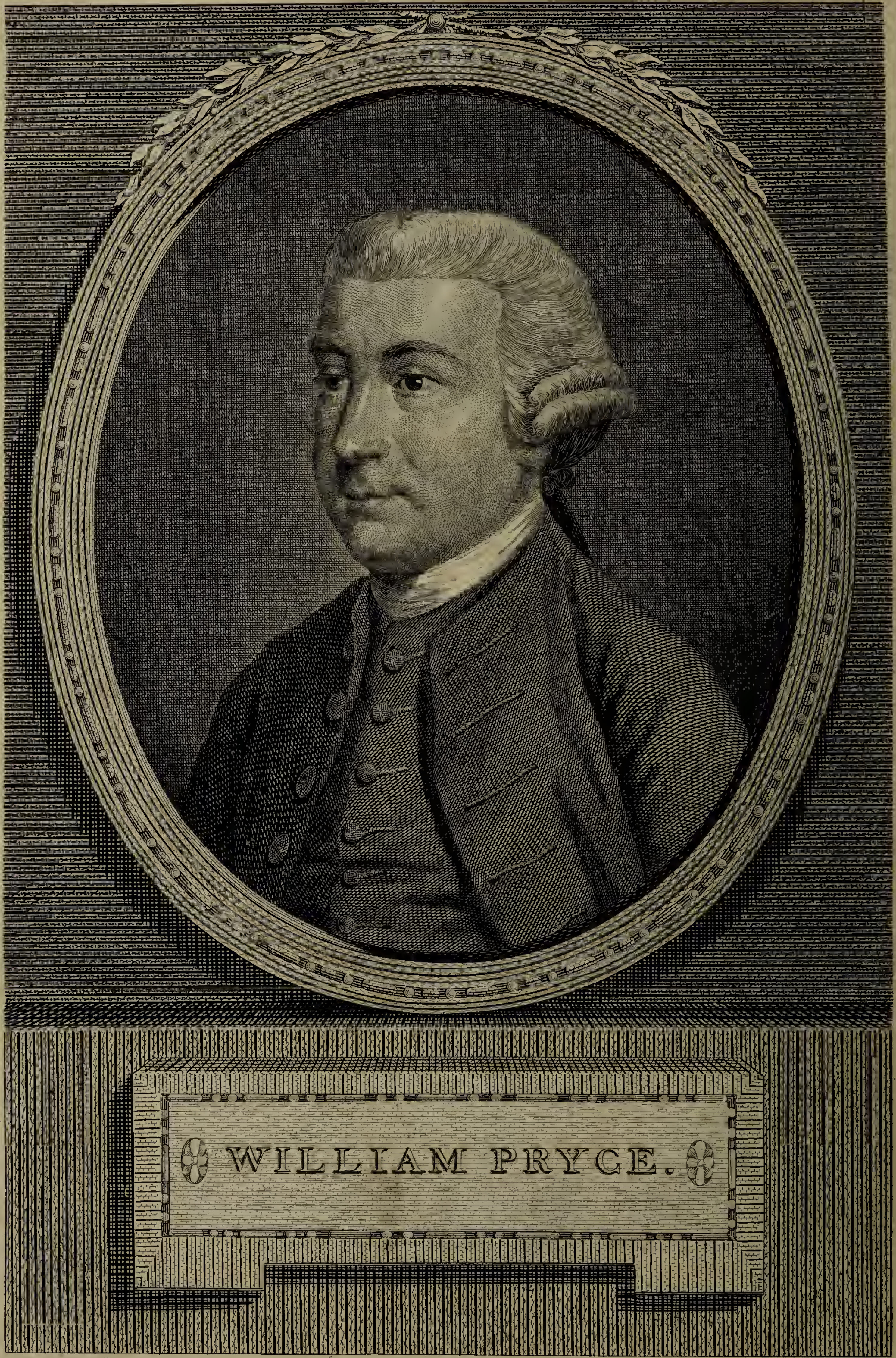

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CONTAINING

THE THEORY AND NATURAL HISTORY OF

STRATA, FISSURES, AND LODES,

WITH THE METHODS OF

DISCOVERING AND WORKING OF TIN, COPPER, AND LEAD MINES,

AND OF

CLEANSING AND METALIZING THEIR PRODUCTS;

SHEWING EACH PARTICULAR PROCESS FOR

DRESSING, ASSAYING, AND SMELTING OF ORES.

TO WHICH IS ADDED,

AN EXPLANATION OF THE TERMS AND IDIOMS OF MINERS.

By W. PRYCE, of REDRUTH in CORNWALL.

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Effodiunt STANNUM, *&c.* DIOD. SICUL. Latin Tranſlat.

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P R E F A C E.

THE practical part of the following work was gradually collected when the writer was very young; and what was begun to be written in detached ſheets, afterwards became the materials of an intereſting treatiſe. This part, indeed, may juſtly be deemed the moſt valuable of the whole, as it tends to inform the publick of matters very little underſtood or conſidered beyond the confines of a Mineral diſtrict.

Minerals that are plenty and precious being generally confined to ſmall tracts of country and a barren ſoil, are therefore remote from that publick obſervation which commerce and agriculture ſo deſervedly attract: yet it is a matter of aſtoniſhment, that an object of the firſt national conſequence, in point of time, ſhould ſo long remain, even to the preſent hour, a ſecret limited to a few illiterate people. It is well known, that Tin and Lead were the firſt and grandeſt ſtaples of Great-Britain, particularly the former, which introduced a trade and navigation before unknown to the diſcoverers of our weſtern coaſts. This trade founded on Mining ſtill ſubſiſts, with many practical improvements and diſcoveries; and though corn and wool have contributed the largeſt ſhare of riches and population to theſe flouriſhing kingdoms, yet that conſideration does not by any means leſſen the importance of the Mining intereſt. When we reflect upon the vaſt profuſion of Silver, Tin, Copper, Lead, Iron, and Coal, yearly produced from the bowels of our Mines, which exceedingly ſurpaſſes our internal conſumption, and therefore muſt afford a very conſiderable branch of commerce; we ſhall find it difficult to account for that ſupineneſs, which has hitherto declined the inveſtigation of a ſubject of ſo much national importance.

The want of ſuch aſſiſtance, in the direction of the uſeful art of Mining, as it is hoped this treatiſe may afford, has been long complained of. It cannot, however, be denied that our Mines are moftly well conducted; yet no fmall advantages may be derived from reducing the vague practice of common Miners to a regular fcience, and bringing the experience of many into a fingle point of view. Nor will thofe advantages be confined folely to practical Miners: every corner of this ifland, Ireland, and many of the colonies, abounds with a variety of Minerals, wholly unknown to the poffeffors; and was the knowledge of the indications of Metals, and the mode of working Mines more diffufed, new difcoveries would daily be made to the great profit of landed proprietors, and the advantage of the publick, by increafing its revenue, and employing confiderable numbers of the laborious poor. As a ftriking proof of the want of fuch a treatife, before the latter end of the laft century, vaft quantities of rich Copper Ore in Cornwall were thrown away as ufelefs! Indeed, it may be fafely faid, that eleven-twelfths of his Majefty's fubjects are totally unacquainted with any part or branch of our enquiry, that by itfelf, and its great confumption of various materials, brings in fo great a revenue to the crown, and fo much wealth to the community.

To acquire a competent knowledge in Mines, &c. a long refidence in their vicinity is certainly neceffary; and this advantage, at leaft, I can with truth lay claim to: yet as this is the writer's firft attempt in literary compofition, it will, for that reafon, have many faults; and he muft rely on the candour of the publick for the favourable reception of an undertaking that ought long ago to have employed the ableft hand. However, I have not omitted to take the opinions of many perfons well verfed in the various departments of this work, which, from the number of natural and practical difcoveries it contains, and the vaft importance of the general fubject, I may venture to pronounce, with all its faults, a valuable acquifition to the library of every nobleman and gentleman in thefe kingdoms.

The great parts of this work are arranged in the following order. The firft book treats of the origin, formation, and fubftance of Minerals and Metals; the firft and fecond chapters of which inculcate the doctrine of water, as the folvent, vehicle, and cement of Metals and Minerals, or their principles, in proportion to the faturation of the one, and the magnetifm of the refpective nidufes of the other. The theory here given, is, in fome inftances, eftablifhed in the procefs of precipitation. The third chapter, which treats of the fubftances of Minerals, Metals,

and

and Salts, is dry and tedious; but as it was thought a neceſſary addition to the preceding chapters, it could not be omitted. With reſpect to the nature and hiſtory of Minerals, I confine myſelf to thoſe of Cornwall only; and as they occur in the courſe of my work, have deſcribed each in its incidental place. My readers will eaſily perceive, that if I had ſyſtematically obſerved thoſe rules of genera, claſs, and order, laid down by Hill, Da Coſta, Cronſtedt, and others, I ſhould have ſpun out my treatiſe in a needleſs detail of matters foreign to the profeſſed ſubject of it.

The ſecond book treats of the theory and natural hiſtory of Strata, Fiſſures, and Lodes, with reſpect to their formation, direction, inclination, interruption, elevation, and depreſſion. The theory advanced in the firſt and third chapters was adopted by the reverend Dr. Borlaſe, and as it has been well received by the criticks of his time, it is hoped that it may ſtill paſs till a better can be found: and after all the opinions of the ſeveral naturaliſts are collated, and the moſt probable are ſelected, the matter will ſtill remain a meer poſtulatum; ſo that we would preſume to judge of theſe only from their viſible effects in the Mines of Cornwall. The ſecond chapter contains little or no theory, being only a natural hiſtory of the contents of Lodes, according to their outward appearance; and any perſon a little converſant with Mineral Ores, may form a tolerable judgment of their contents from the deſcription here given of them.

The third book contains the practical part of Mining; the methods of diſcovering and working Mines, the particular proceſs for digging and raiſing of Ores, and the machinery for drawing water. Though in this part the reader may find a fund of information that he has never ſeen opened before; yet it can be conſidered only as a ſummary of Mining, it being endleſs to enter into all its different modifications. The firſt chapter treats of the diſcovery of Mines by the Virgula, Shoding, and Coſteaning, eſpecially the former; and gives an improved idea of a ſcience in diſcovering Mines very little underſtood out of Cornwall. The merit of the eſſay on the Virgula Divinatoria is due to Mr. William Cookworthy, of Plymouth; and though the virtues of the rod may not be eaſily allowed by the incredulous, yet for my own part, I want no further evidence of its properties than I have already obtained to fix my opinion of its virtues. At leaſt, the memoir is curious, and the ſubject deſerves to be further enquired into. In the method of Shoding,

I have

I have been more full than any preceding writer; and, I hope, with a judgment that will refcue this fcience from the darknefs with which it was enveloped. The fecond chapter contains an account of the methods of Streaming in its prefent improved ftate. This immediately follows the chapter on Shoding, becaufe of its near affinity to that fubject. The practical part of Shoding and Streaming is founded upon a belief of the Noachian deluge and its effects, which are inconteftably verified in Shode and Stream works. In the third chapter, the effectual working of a Mine is exhibited in the finking of Shafts, driving Adits, digging and raifing of Ores, drawing the water, and every other operation under-ground. This is intended to explain the feveral parts of a Mine, and their dependency on each other; and to evince that fuch contingencies muft be in all Mines, although varied in their fituations according to the different circumftances of different Mines. To this is added, a parallel fection of the greateft Mine now at work in Cornwall, to illuftrate the whole. The chapter following relates to the management of a Mine when in a proper courfe of working; wherein fuch maxims are laid down, that a novice in conducting a Mine may underftand fome matters indifpenfably connected with that art. The laft chapter of this book treats of Damps, Dialling, and Levelling, with practical inftances and remarks, fupported by experience, and altogether neceffary.

The fourth book treats of the feveral manuductions ufed in dreffing of Tin, Copper, and Lead Ores, and contains fome brief remarks upon dreffing Gold, Silver, &c. Though the general manner of dreffing Copper Ore was firft taken from the methods ufed in the Lead Mines, yet there are fo great a variety of Copper Ores requiring very oppofite treatment in their dreffing, that I hope the fubject will be found greatly improved. The dreffing of Tin is indeed an art confined to the ftannaries only; yet the curious delicate manner in which it is manufactured in the dreffing, may furnifh many improvable and beneficial hints for the cleanfing of other Minerals from their fordes. I have been very accurate in defcribing the manner of dreffing Tin Ore, as I have had ample experience in that bufinefs; and I doubt not of its proving a ufeful and general ftandard in that branch of Mineralogy.

The beginning of the fifth book confifts of a memoir upon affaying, and more particularly upon a part of the Docimaftick art, which has never been fo experimentally treated of before, viz.

viz. How to aſſay Mundicks and Tin for Gold or Silver; by which proceſſes the curious may judge how far the Mundicks of one place are ſuperior to thoſe of another for the precious Metals, or whether they contain any Silver or Gold. The proceſſes for aſſaying Copper Ores by calcination, and by the regule way, are both infallible, if the operator will be attentive to his buſineſs. Theſe proceſſes are little known out of the Corniſh aſſay offices, and have been too long kept profoundly ſecret, for purpoſes which the reader will readily comprehend. The method of aſſaying Tin Ore is very ſimple and efficacious, from the eaſy fuſibility of its Metal. An adept in trying Copper Ores will ſoon know how to manage in aſſaying Cobalt, by the mode preſented to his view in this chapter.

The laſt and grand object, is the manufactory of Tin and Copper Ores into their reſpective Metals; and I have ſet forth, as ſuccinctly and clearly as the materials I have obtained would allow, the proceſſes of ſmelting and metallizing thoſe products, without infringing too much upon the ſecrets of private trade. And though I have not forgotten to point out the oppreſſions of monopoly, yet it is with leſs ſeverity than is due to the magnitude of the evil, and its miſchievous effects.

The Appendix treats of the great improvement in the ſteam fire engine by Mr. Watt; an invention of more conſequence to the Mining intereſt of Great-Britain, than any diſcovery that has been made for half a century; and I hope to ſee its univerſal uſe eſtabliſhed in a very ſhort time.

As the idioms and terms of Corniſh Miners are moſtly derived from the ancient Corniſh Britiſh dialect, and therefore not eaſily intelligible to gentlemen unaccuſtomed to Mining, who may have occaſion to converſe or correſpond with them; to prevent miſconception, I have ſubjoined an explanation of thoſe terms in alphabetical order, including the relation they bear to thoſe of the Lead Mines and Collieries.

C O N T E N T S.

I N T R O D U C T I O N.

B O O K I.

C H A P. I.

The Origin and Formation of Metals and Minerals.

 formation

CHAP. III.

Of Metals and Minerals more immediately, and the Fluxes for affaying them.

formed

C O N T E N T S.

B O O K II.

C H A P. I.

Of the Strata of the Earth, and the Fiſſures in which Metals are found; their Direction, Inclination, or Underlie, &c.

 water,

CHAP. II.

Of the different kinds of Lodes in refpect of the Earth and Stones they contain.

CHAP. III.

How Lodes are difordered, interrupted, fractured, elevated, and depreffed, by the Intervention of Crofs-Goffans, Flookans, Slides, Contras, &c.

BOOK III.

CHAP. I.

The various, ancient, and modern Methods for Diſcovery of Mines, &c. by Shoding, Coſteaning, &c. with ſeveral very curious Diſquiſitions, Obſervations, and Experiments, upon the Virtues and Uſes of the Virgula Divinatoria.

C H A P. II.

Upon Streaming, Drefling, and Smelting of Stream Tin in the Blowing-Houfe or Blaft-Furnace.

C H A P. III.

Of Bounds, and the Manner of taking a Set or Grant for Mining; of ſinking Shafts, driving Adits, digging and raiſing of Ores, drawing the Water, and working the Mines.

* * * C H A P.

C H A P. IV.

General Obſervations on Mines and the Management of them.

C H A P. V.

Of Damps in Mines, and of Levelling and Dialling Mines, Adits, &c.

B O O K

BOOK IV.

CHAP. I.

The Method of Sampling and Vanning of Tin-ftuff, and of the Stamping, Burning or Calcining, and Dreffing the fame; with the Manner of Dreffing the Leavings, Loobs, &c.

CHAP. II.

The various Manuductions ufed in dreffing of Copper and Lead Ores, and Sampling Copper Ores for Sale.

Dreffing

CHAP. III.

A Summary of the Dreffing of Gold, Silver, and Semi-Metals, &c.

BOOK V.

CHAP. I.

On the Art of Affaying Ores and Minerals; defcribing the Utenfils and Fluxes for Affaying.

C H A P. II.

Of Smelting of Copper Ores in the great Furnaces called Copper Works.

C H A P. III.

Of Smelting Tin Ore, or Black Tin, in the great Furnaces at the Smelting-Houſe.

C O N T E N T S.

C H A P. IV.

INTRO-

INTRODUCTION.

AS all ages from the foundation of the world, have been productive of continual improvements, and different modifications of matter; ſo likewiſe every kingdom and province, has experienced the viciſſitude of time and things, and that rotation to which all matter is liable. However, amidſt all the changes of ſublunary affairs, each country reſpectively has been ever remarkable for its peculiar produce, trade, and commerce; and we may ſuppoſe from the nature of particular things, which are ſolid and durable, that the conſtituent principles of Minerals and Metals, although ſubject to a degree of fluctuation common to the mundane ſyſtem, have undergone the leaſt variety of any matter. Hence it is we find, that moſt countries, which have been remarkable, time out of mind, for ſupplying the world with certain Minerals and Metals, reſpectively maintain to this day a ſuperiority for their ſingular products.

Among ſuch, the ancient kingdom of Dunmonium, which ſignifies Hills of Tin Mines, and takes its name from thence, may with great propriety claim a diſtinction in the annals of Metallurgy; but more eminently ought that part of it called Cornwall to be diſtinguiſhed, as having, perhaps, yielded more Tin in one year, than Devonſhire has done in half a century. I may yet proceed, and infer, how ſuper-eminently this little province of Great-Britain deſerves to be ranked amongſt the firſt principles of this iſland, as a nation and people, whoſe very name, according to the ancient authority of Bochart, and the later opinion of Boerhave, is derived from Bratanack, which, in the Phenician language, ſignifies The Land of Tin.

Tyre and Sidon were ſituate in Phenicia, a part of the ancient Paleſtine; and were the firſt maritime powers that we read of, either in ſacred or profane hiſtory. Tyre (the grand ſea-port and mart of Phenicia) was taken and entirely demoliſhed by Nebuchadnezzar, in the thirty-ſecond year of his reign, and in the year 573 before Chriſt; ſo that the lateſt date of their trading here, cannot be leſs than four and twenty centuries

ſince.

ſince. I believe it is agreed by all writers, that they were the firſt who uſed to frequent this iſland for commerce; that they traded upon the weſtern coaſts of Cornwall, full ſix hundred years before the coming of our Saviour; and that their navigation to it, was for the ſake of our Tin. They conſidered this traffick as a point of ſuch conſequence, that they erected forts and caſtles on our coaſts for the protection and preſervation of their commerce; and a great number of the proper names of men and places in Cornwall, are plainly derived from the Syriac tongue.

The learned doctor Borlaſe inclines to an etymology from a Hebrew root, whoſe termination Tania of Grecian extraction, gives another idea of the name in queſtion: but if we admit the Phenician language to be immediately derived from her neighbour, and the mother of tongues, we may incline very eaſily to conſider our county, as the parent of one general name for the whole iſland; and that the antiquity of our Tin trade has been eſtabliſhed upon mercantile principles, for at leaſt two thouſand four hundred years paſt.

I hope the reader will not judge it improbable, if we ſuppoſe that the firſt inhabitants of Cornwall and Devon, after the flood, were well acquainted with Tin in its richeſt Mineral ſtate; for it requires no uncommon degree of intellectual examination to comprehend, that, in the earlieſt ages from that grand epocha, our richeſt ſhode and ſtream Tin muſt have been found plentifully diſſeminated upon the ſurface of our vallies, and the ſides of our hills and mountains. Thoſe fragments and nodules, by their colour, ſhape, and gravity, muſt have attracted the notice and conſideration of the firſt natives, if they did not allure the attention of thoſe immediate emigrants who were "ſcattered "over the face of the earth, when the ſons of men multiplied "in the land." We have, therefore, much plauſibility on our ſide to conjecture, that Tin was known as a Metal among our progenitors, ſo long as four and thirty centuries ago.

They could not obſerve the ſingular ſhape and weight of ſhode and ſtream Tin, without conſidering the contents as a Mineral, which by its ſuperior gravity would afford ſome metalline ſubſtance; eſpecially, when by a compariſon with the Mineral Ores of other Metals, known long before the flood, they muſt have had all the reaſon in the world to conclude upon its metalline conſiſtence. Information, or perhaps experience

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in the methods of extracting Metal from other Minerals, muſt have directed them in what manner to purge our Metal from its native droſs. The richneſs of the Mineral, and its natural eaſy fluxility in the fire, ſoon confirmed their conjectures; and the beautiful colour, and innocent properties of the Metal, no doubt rendered it as valuable in their eſtimation as Silver and Gold; until, by great abundance, which renders all things cheap, it ſunk in the ſcale of comparative excellence with thoſe Metals.

Tin, in its Mineral ſtate, being totally unknown to all other countries but our own, affords ample reaſon to aſſert, that we ſupplied all the markets of Europe and Aſia with that commodity in early ages. Accordingly, we read of Tin in Judah ſo long back as the reigns of Uzziah, Jotham, Ahaz, and Hezekiah; (Iſa. i. 25.) and alſo in the writings of Homer, who flouriſhed 907 years before Chriſt:

"In hiſſing flames, huge Silver bars are roll'd,
"And ſtubborn Braſs, and Tin, and ſolid Gold.
"A darker Metal mixt intrench'd the place,
"And pales of glittering Tin th' encloſure grace."
Pope's Hom. Iliad, L. 18.

From hence we would infer, that all Tin produced in the primitive ages of the poſt-diluvian world, was from ſtream or ſhode; perhaps many ages before deep Mining was at all known. We have authority to ſay, from Mr. Carew, and a M. S. of Serjeant Maynard, which we have ſeen, that the working of Lodes was unknown to our anceſtors in the firſt ten centuries after the incarnation; ſo that we may reaſonably conclude, our Lode or Mine works are not of 700 years ſtanding.

It has been hitherto an object of enquiry, from whence our Tin was ſhipped in the time of the Phenicians: ſome ſay, from the Caſſiterides or Scilly Iſlands; Bolerium, or the Land's-End; others ſay, from St. Michael's Mount; and others, from Oſtium Kenionis Valubia, or Falmouth.

The ignorance of true geography and navigation in the times of Timæus, Strabo, Diodorus Siculus, Polybius, and all the ancient hiſtorians and geographers, was ſo great, and their deſcriptions ſo obſcure and contradictory, that it may ever remain a matter of conjecture and controverſy, whence our Tin was exported for

Phenicia or Rome, by the records they have left behind them. It feems probable, that they included the promontory of Bolerium among the Caffiterides, and denominated all the fouth-weftern coaft of Cornwall as part of them; which being the firft land difcovered by the navigators of thofe days, gave one general appellation to the whole.

The veftigia of any Tin Lodes, Mines, or workings, in the iflands of Scilly, are infufficient to convince us, that they only gave this beautiful Metal to the world: the remains of any fuch workings are fcarcely difcernible; for there is but one place, that exhibits even an imperfect appearance of a Mine; and fo neceffary an appendage to a Mine as an adit to unwater the workings, is not to be feen in all the iflands. If, in thofe days, the Metal was produced from ftream or fhode ftones only, we muft undoubtedly have difcovered, in latter times, thofe Lodes or veins from whence they were difmembered by the deluge. They muft have been wrought for Tin fince the earlier ages; and fome remains of fuch Lodes would now be vifible on the fea coaft or cliffs, if many fuch had ever been: we are, therefore, ftrongly induced to believe, that the Mineral Ore of Tin was anciently procured within the four weftern hundreds of Cornwall, and there fmelted into white Tin, by charcoal fires, as the want of a proper bitumen in thofe days, and the entire demolition of all the woods near the Tin Mines, very plainly evince.

Befides, unlefs we make great allowances indeed for encroachments of the ocean fince thofe early ages, the iflands of Scilly are merely in their prefent ftate a clufter of barren rocks, the principal of them meafuring but three miles long and two wide. Whence fhould all this Tin arife? Likewife the ftate of population then could not admit of emigrations from the infular continent for digging, raifing, and fmelting a Metal, which the mother ifland produced in fuch vaft profufion from her own bowels.

Without partiality to any particular opinion, we muft own the harbour of Falmouth feems to us the moft commodious, both for natives and foreigners, to have carried on the bufinefs for exportation of this grand monopoly, which fupplied all the Mediterranean markets: and we are not fingular in this thought, but are very plaufibly fupported by a learned collator of our own country, in whofe MS. we find an ingenious

etymology

etymology and topographical agreement in relation to the matter before us. (Hals).

" This harbour of Falmouth has been famous over Europe and Afia ever fince the ifland was firft known, though but darkly diftinguifhed by the Greeks and Romans under feveral appellations; for inftance, by one (in Greek) The Mouth of the Dunmonii Ifland : for neither Greeks nor Romans knew whether this province of the Dunmonii was an ifland of itfelf, or part of the infular continent of Britain, till the time of the Roman emperor Domitian, when he circumnavigated the whole ifland with his fleet. Befides, it was the cuftom of the Jews and Greeks, to call remote and ftrange lands, Iflands, and the natives, Iflanders : to which purpofe we read, Ifaiah lxvi. 19. " Tubal, Javan, and the ifles afar off," which were the continent of Greece and Spain." Alfo, Genefis x. 5. and elfewhere, by the name of the ifles are meant the iflands, and in general all the provinces of Europe. And it is obfervable, that where the prophet Ifaiah foretels the calling of the Gentiles, he makes particular mention of the iflands, (chap. xli. xlii. xlix. li. lx.) which many interpreters have looked upon as a plain intimation, that the Chriftian religion fhould take deepeft root in thofe parts of the world, which were feparated from the Jews by the fea, and peopled by the pofterity of Japhet, who fettled themfelves in the iflands of the Gentiles. So that the iflands, in the prophetical ftile, feem particularly to denote the weftern parts of the world, the weft being often called the fea in fcripture language. But to proceed :

" Strabo calls this mouth of the Vale river, Oftium Kenionis, and more properly Valuba, or Valubia ; that is, the wall, defence, point, or promontory, of the faid Vale, now St. Anthony's Point ; or Val-Ubii, from the colony of the Ubii, a people of Belgia, who planted themfelves on the Vale river before Cæfar's days. (From which Ubii, might come Cornubi-enfis.) Further, Diodorus Siculus tells us, that all Tin was fetched out of Britain : as it is in fome authors, after the Greek verfion, from Νῆσος Ικτα, Κι Οκτα (Nefos Ikta, Ki Octa) which feems to fay in Britifh, firft, the Good Lake, or Haven Ifland, and the fecond (what we now call Bud-Ok) a Bay of Oak Ifland; and, indeed, the memory of fuch Ike feems yet preferved in the prefent names of Car-ike road, the chief part of Falmouth harbour, from whence, to this day, the major part of our Tin is ftill exported ; and Arwynike, and Bud-ike lands, by which

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the ſaid harbour is bounded. Now, this word Ike, I am informed, is derived from the ſame Japhetical origin as the Greek ἥκω, (Eko) venio, to come, arrive at, or enter into a place; and, therefore, as aforeſaid, in Corniſh Britiſh, it means not only a haven of the ſea for traffick, but a place where a river of water hath its current into the ſea; from whence, perhaps, the Latins had their Ictus, to ſignify the courſe of a river. And from this etymology we may the better underſtand the words of Diodorus Siculus, from the Greek rendered into Latin, thus: "Britanni, qui juxta Valerium Promontorium, incolunt, mer-"catoribus, qui eò Stanni gratia navigant, humaniores reliquis "erga hoſpites habentur. Hi ex terrâ ſaxoſâ, cujus venas "ſequuti, effodiunt ſtannum; quod, per ignem eductum, in "quandam inſulam ferunt Britannicorum juxta, quam Ictam "vocant."

"The Iſland which he calls Ictam or Icta, adjoining thus with Britain, is certainly that which is now called the Black Rock Iſland in Car-ike road aforeſaid; which, as he ſaid, was then an iſland at flood or full ſea, though at low water paſſable from the main land. There is alſo a Corniſh MS. of the Creation of the World, a Play, brought into Oxford in 1450, and which is ſtill extant in the Bodleian library there; which will at the ſame time ſerve to evince, that the now Black Rock of Falmouth was in old time the Iſland, the Ikta of Diodorus Siculus, from which Tin was tranſported into Gallia: a few words of it therefore here follow faithfully tranſcribed, with their tranſlation: they being ſpoken as by Solomon, rewarding the builders of the univerſe (a very great abſurdity in the poet) page 151; which was then, perhaps, a true deſcription thereof:

"Banneth an tas wor why;	Bleſſing of the Father on you;
"Why fyth vea gwyr gobery.	You ſhall have your reward.
"Whyr gober eredye	Your wages is prepared
"Warbarth gans ol gweel "Bohellan	Together with all the fields of Bohellan
"Hag goad Penrin entien	And the wood of Penryn entirely,
"An Ennis, hag Arwinick,	The Iſland, and Arwinick,
"Tregimber, hag Kegillick.	Tregember, and Kegillick.
"Anthotho gurry the why chauter."	Of them make you a deed or charter.

Leland

Leland the elder, in his Itinerary, tells us, that this river was encompaſſed about with the loftieſt woods, oaks, and timber trees, that this kingdom afforded, temp. Hen. VII, and was therefore, by the Britons, called Caſſi-tir, and Caſſi-ter; that is to ſay, Woodland. From which place and haven, the Greeks fetching Tin, called it and the Iſland, ſo often here mentioned, in their language, Caſſiteros. In further praiſe of which famous port, may the reader accept the following lines:

In the calm ſouth Valubia's harbour ſtands,
Where Vale with ſea doth join its purer hands;
'Twixt which, to ſhips commodious port is ſhown,
That makes the riches of the world its own.
Ike-ta, and Vale, the Britons chiefeſt pride,
Glory of them, and all the world beſide,
In ſending round the treaſures of its tide.
Greeks and Phenicians here of old have been;
Fetching from hence, furs, hides, pure corn, and Tin,
Before great Cæſar fought Caſſibelyn."

Hals's Paroch. Hiſt.

We may, hence, conclude it very probable, that this part of Great-Britain, was the firſt reſorted to by the moſt ancient maritime powers in Europe and Aſia, on account of its valuable, beautiful, and precious Metal; and therefore gave a name to the whole iſland, which, with ſome little variation, it retains to this day, and proves the antiquity, locality,* and ſuperiority of our product, and its univerſal ſupply for the uſe of mankind.

Such an abundance of Copper Ore, which the Mines produce at this time in Cornwall, is a clear evidence of the fertility of our county in that Metal, preferable perhaps to all the reſt of England for quantity, quality, and employment. Former times might have been equally celebrated for our production of this Metal with that of Tin, had its proximity to the ſurface been ſo great: but this rich and uſeful Metal is placed by divine appointment more remote from the reach of human induſtry; and ſo deeply concreted in the bowels of the earth, as to elude the ſearch of man, without the help of mechanicks and philoſophy:

* Tin is a Metal become very neceſſary in common life, and yet in ſome meaſure the rareſt of all others. There are but few Tin Mines in Germany; nay, in reſpect of other Metals, few in Europe. All in Germany, as far as I know, are thoſe in Miſnia, Bohemia, and Carinthia; and formerly in Fitchelberg at Wonſiedel. Whole kingdoms, as Sweden, Denmark, Norway, &c. have no ſuch Mines, but are ſupplied with Tin from England. Auth. Preface to Henckel's Pyritologia.

no

no wonder, then, we are not renowned for discoveries of this Metal in the distant ages of antiquity. When arts and sciences were in their infancy, it was impossible to lay open the deep treasures of the terrene system. Men, money, and materials, in former times, were more scarce: and the increase of population and specie in latter days, have progressively and mutually operated, to lay open and discover the deep recesses of the earth, and the hidden treasures of the stupendous contrivance in the matter and formation of our globe.

The superficial site of one Metal, and the central tendency of the other, give us different ideas how they are to be searched after and wrought; and those ideas can no way concatenate, but wherein those Metals may be discovered, cæteris paribus, equally central or superficial.

It is very seldom that Tin continues rich and worth the working, beyond fifty fathoms deep; and it is absolutely certain, that Copper is not often wrought in great abundance, till past that depth, to an hundred fathoms or more. It is also a fact, that most Mines with us, both of Tin and Copper, being richer in quality near the surface, and by that circumstance attended with less expence in the working, do for the most part reward the adventurers with very ample gain.

It should, therefore, seem eligible to bestow our attention on those skin-deep adventures, preferably to the deep Mines; but this is by no means the case in practical Mining: for, if a Mine, when she is first discovered, throws up a large profit to the adventurers, and fails soon after to their loss and detriment; they nevertheless pursue their object, under the most unpromising circumstances, with unremitting ardour, patience, industry, and resolution, scarcely parallel in any other unfortunate undertaking under the sun. Every little stone of Ore brings along with it new hopes, and fresh vigour. It fans the glimmering flame of adventure, which had been kindled before by the fire of a certain Provincial Spirit, that seems to animate the natives of Cornwall, and to deserve that success which they cannot always command.

Neither is it wise to rely on the success of shallow Mines, though their profits may be sudden; or to desert them because their depth may prove unfavourable for some time after; for it is experimentally true, that most Mines of considerable depth, though vaſtly expenſive, and the Mineral of leſs intrinſick worth, do, in their ſuperlative quantity, certainty, and ſteadineſs, make complete and ſubſtantial amends for the great labour, and perſevering aſſiduity of their proprietors. In ſupport of which I may venture to affirm, that ſix Mines produce ſix parts in eight of all the Copper Ore of the county at this time.

Tin in its metallick ſtate, being to Copper but as ſixty to a hundred, is notwithſtanding more rich in its minerallick Ore than Copper, as it comes from the Mine; therefore they require different management in the dreſſing, and cleanſing them for the furnace. The former from the ſmallneſs of its particles, and extreme hardneſs of the ſtone in which it is frequently found, requires to be triturated or pulverized as ſmall as the fineſt ſand, to go through repeated ablutions, calcinations, &c. and be taken up with the utmoſt nicety and preciſion; which renders it of leſs nett value to the Miner on account of ſo much trouble and expence in the minerallick manufactory thereof: but as it affords ſo conſiderable an employment for the children of poor labourers, from ſix years old and upwards, they are generally engaged in that branch before they commence underground Tinners, and from the age of puberty are indiſcriminately denominated Tinners by that means.

Among the working Tinners, this darling Metal holds her empire in the heart; probably becauſe of its locality, and the privileges, immunities, and ſtannary laws, whereby they are diſtinguiſhed, ſupported, and protected, as a ſeparate body of people.

Copper, as I have before ſaid, being placed in the more interior ſtrata of the earth, requires great ſkill in hydraulicks, and mechanicks. The appropriate qualities, gravitation, and denſity of the elements, ought to be nicely weighed in the ſcale of ſound judgment. The expence of coal, candles, timber, leather, ropes, gunpowder, and various other materials, added to the labour of men, women, children, and horſes, occaſion ſuch a vaſt monthly charge, as will not eaſily be credited by thoſe who are unacquainted with Mining. It is well known, however, that ſome Copper Mines now extant, have each ſupported, for ſeveral years paſt, a monthly expence of two thouſand five hundred pounds, including the land owner's ſhare, which is generally a ſixth, ſeventh, or eighth part, in ſpecie, of the whole proceeds.

From a comparative view of the charges in working of Tin and Copper Mines, we may draw this corollary, viz. The former is wrought upon more dependent principles than the latter, which cannot be embowelled in great quantities, without the help of foreign auxiliaries, ſuch as coal, and very large timber particularly. The Mining intereſt of Cornwall, therefore, deſerves great attention from the government, the nobility and gentry of the united kingdoms, as tending to a conſiderable national advantage in the conſumption of ſo many materials neceſſary for the conduct and maintenance of the Mines; whereby great trade is kept up, large duties to the community are paid, and a conſtant uniform nurſery for ſeamen is eaſily and cheaply preſerved, as our quota, of additional ſupport of the trade, navigation, and ſecurity of theſe kingdoms.

With much ſatisfaction we can reflect upon the ſingular nature of our ſtaple commodities, they being attainable at the certain loſs of none but thoſe who ſeek a recompence from the purſuit. Now in ſome kinds of trade and buſineſs, what is the profit in one man's hand, is frequently ſo much loſs to ſome other individual, from whom it is either immediately or laterally derived. It is an axiom in trade, that "One man's loſs is another man's "gain;" but in the caſe before us, we take from no perſon's bag, but ſtrive only to obtain the treaſure of the deep, which in its hidden ſtate yields neither glory to God nor ſervice to man: "And all this out of a narrow ſlip of land uſually of the moſt "barren hilly kind, without diſtreſſing tillage, paſture, and "the like, ſcarcely worth the remarking; and very far ſhort of "the improvements in rent for thoſe lands which are in the "vicinity of the Mines." (Borlaſe).

Mr. Scawen, of Molinek, was vice-warden of the Stannaries in Charles the ſecond's time; and in a note of his, which the writer has ſeen, complains, that the Tin revenues were then ſmall; but, in the preceding reigns of James the firſt, and Charles the firſt, the amount of Block-Tin yearly, was from fourteen hundred to ſixteen hundred tons. It was alſo found by the laſt two farms in queen Anne's reign, and the beginning of George the firſt, that Block-Tin, one year with another, amounted to ſomething more than ſixteen hundred; ſo that, in the ſpace of one hundred and ten years, its mean proportion was equal to fifteen hundred tons ℔ annum. Since the foregoing time, we obſerve a gradual increaſe for thirty years following; for, in the year 1742, a propoſal was made by the Mines Royal Company

Company in London, to raiſe one hundred and forty thouſand pounds to encourage the Tin trade by farming that commodity for ſeven years at a certain price. A committee of Corniſh gentlemen were appointed to conſider of the propoſals; and they reported, "That the quantity of Tin raiſed yearly in "Cornwall, at an average for many years laſt paſt, hath been "about two thouſand one hundred tons; and reſolved, that "three pounds nine ſhillings for grain Tin, and three pounds "five ſhillings ℔ hundred weight for common Tin, are the "loweſt prices for which ſuch Tin will be ſold to the con-"tractors, excluſive of all coinage duties and fees."

The rapid increaſe of the produce of our Tin Mines for the laſt thirty years, is ſcarcely credible: it is, however, a fact, that we have coined three thouſand ſix hundred tons of Block-Tin in one year; and, for the laſt twenty years, the annual average has been about three thouſand tons; which is double the quantity coined annually but ſixty years ago, and one-third increaſe for the laſt thirty.

No leſs extraordinary has been the vaſt addition to the ſales of Copper Ore within the laſt twenty years; eſpecially as Mining for Copper, only commenced with the preſent century; the little which had been raiſed before, being adventitious, and accidentally met with in purſuit of Tin.

According to the following accounts, which are faithfully tranſcribed from the Copper Ore buyers books, we find the quantity ſold, from 1726 incluſive to the end of 1735, was ſixty-four thouſand eight hundred tons, at an average price of ſeven pounds fifteen ſhillings and tenpence ℔ ton, amounting to four hundred and ſeventy-three thouſand five hundred pounds, which muſt have been yearly forty-ſeven thouſand three hundred and fifty pounds. From 1736 incluſive to the end of 1745, ſeventy-five thouſand five hundred and twenty tons of Copper Ore were ſold at ſeven pounds eight ſhillings and ſixpence average price, the amount five hundred and ſixty thouſand one hundred and ſix pounds in the groſs, and fifty-ſix thouſand and ten pounds yearly. From 1746 incluſive to the end of 1755, the quantity ſold was ninety-eight thouſand ſeven hundred and ninety tons at ſeven pounds eight ſhillings the ton, the amount ſeven hundred and thirty-one thouſand four hundred and fifty-ſeven pounds; annually ſeventy-three thouſand one hundred and forty-five pounds. From 1756 incluſive to the end of 1765, the

the quantum ſold made one hundred and ſixty-nine thouſand ſix hundred and ninety-nine tons, at the average price of ſeven pounds ſix ſhillings and ſixpence, amounting to the ſum of one million two hundred and forty-three thouſand and forty-five pounds, and one hundred and twenty-four thouſand three hundred and four pounds yearly. Laſtly, from 1766 to the end of the laſt year, two hundred and ſixty-four thouſand two hundred and ſeventy-three tons of Copper Ore were diſpoſed of at ſix pounds fourteen ſhillings and ſixpence ℔ ton, amounting in all to one million ſeven hundred and ſeventy-eight thouſand three hundred and thirty-ſeven pounds, which muſt have returned one hundred and ſeventy-ſeven thouſand eight hundred and thirty-three pounds every year of the laſt ten.

In order to form a more comprehenſive view of the progreſs ſo lately made in Mining for Copper, we have preſented the reader with a comparative ſcale of the above Ores, &c. where he may ſee for himſelf, the advance and improvement, which have been made in the ſcience of Metallurgy in this part of Great-Britain. And when we reflect upon thoſe great and ſudden improvements in the art of Mining, we may juſtly give ourſelves all the merit, which we really deſerve for our ſuperior excellence to all the reſt of our fellow ſubjects in this ſingular branch of knowledge. We do not know how much our gratulations may be damped, when we further obſerve, that (from ſome cauſe which we cannot perfectly account for at this time) the intrinſick value of our hard gotten commodities, has decreaſed in ſome ratio to the advance in quantity, which ought to be a matter of very ſerious enquiry with all the gentlemen of Cornwall, whom it ſo nearly concerns, and from whom we may expect that redreſs by their united efforts, which the declenſion of our Mine trade ſo greatly requires.

It is the popular opinion, that no real ſurpluſage beyond the charges of Mining do ariſe to the adventurers in general; and that in Tin particularly, the credits are unequal to the outgoings. Neverthleſs, we ſee, in our county, that many men have made opulent fortunes by their ſucceſs in Mining; therefore it is difficult to account for the truth of this matter, unleſs we ſuppoſe the profit of the great Mines to be ſunk in the unfortunate adventures, and like national lotteries, the individual profit to be taken out of the general loſs. It is indubitable, however, that the publick is manifeſtly enriched by the great trade and circulation of money, conſequential to this peculiar buſineſs.

Whether this equipoſe in the profit and loſs, is a fact, or only a falſe allegation, I will not take upon me to ſay; but if they be not tantamount to each other, we verily believe upon the whole, the gain is far ſhort of that recompence which is due to the reſolution and ſedulous purſuit of the Mine Adventurers in Cornwall.

Suppoſing the proceeds in Tin and Copper to be annually four hundred thouſand pounds, and the ſeparate gain being aggregate; upon a dividend of twelve and a half ℔ cent. it will come out fifty thouſand pounds, which is only a profit of one-eighth upon the certain riſk of ſo large a ſum: but thoſe who are converſant in Mining, we are well aſſured, would be very happy if they could promiſe themſelves only ſeven blanks to one prize, which from unlucky experience we know to be not the caſe, and that nineteen blanks to a prize, will more nearly quadrate with the truth of the matter, by which our former dividend is reduced to five ℔ cent. and the groſs gain to only twenty thouſand pounds ℔ annum.

This, however, makes ſome profit appear; but how ſmall, if true! how inadequate to the ſum laid out and expended! This ſhews the infatuation, and deluſive hopes of political gaming, under which ſtigma it apparently lies. We ſhall forbear any further reflections upon the ſubject, leſt we incur the blame and reproach of our neighbours and countrymen; but as we write for the publick eye, we find it neceſſary to relate facts as they occur, whether they are unpleaſing to the intereſted or not. In purſuance of which determination, we hope the landholders will hold us excuſable, when we aſſert upon the cleareſt conviction, that they contribute by their heavy exactions to deprive the induſtrious adventurers of too large a proportion of that profit, which ought to be applied for the encouragement and reward of their arduous and expenſive undertakings. At a medium, the Lords of the ſoil have one-ſeventh part clear from all expence: now the one-ſeventh of four hundred thouſand pounds, being fifty-ſeven thouſand one hundred and forty-two pounds, it appears, by a ſtriking compariſon, for whom the Mines are wrought, and who are the principal gainers thereby; and very completely accounts for the great complaiſance, candour, gratitude, and generoſity of thoſe gentlemen, to the ſeveral Adventurers in their reſpective eſtates.

At

At this time, when all the neceſſaries of life are high in value, the price of all manner of materials advanced, the wages of labourers from a natural conſequence proportionably increaſed, the price for Tin ſunk down from three pounds ten ſhillings to three pounds, and Copper Ore fallen more than thirty ℔ cent. below the true ſtandard, have we not great reaſon to fear the event of ſuch combined and adverſe cauſes to the proſperity of this county ? Is it not alarming ? And how ſhall we account for all that ſupineneſs which is manifeſted by thoſe, whoſe intereſt and buſineſs it ſhould be to mitigate the recited diſtreſſes of a laborious and uſeful community ?

Government would reap a very fruitful harveſt annually, from a ſuitable encouragement of the Mining intereſt in Cornwall. We believe, if the managers of publick affairs would leſſen ſome of the heavy duties upon our materials, and wholly remit others, ſuch indulgence would operate as a bounty, and greatly multiply our contributions to the national revenue, by animating the Mine Adventurers to rework ſeveral deep expenſive Mines, now dormant through the great preſſure of weighty impoſts, upon the back of many natural difficulties and obſtructions.

The drawback upon coal uſed in our ſmelting-houſes and fire engines, has been attended with ſuch happy conſequences for the publick, that we may venture to affirm, not one-fifth of the fire ſteam engines now working, would ever have been erected without ſuch encouragement. Thirty-ſix years ago, this county had only one fire engine in it : ſince which time above three ſcore have been erected, and more than half of them have been rebuilt, or enlarged in the diameter of their cylindrical dimenſions.

We ſhall leave the publick to reflect and animadvert upon this notorious truth.

An Account of all the Copper Ores ſold in Cornwall the laſt fifty Years; their Tonnage, Amount, Price, and Value.

Date	Ten Years Tonnage	ditto Average Price ⅌ Ton	Amount	Average Annual Tonnage	Average Annual Amount
1726 1735	64,800	£7 15 10	£473,500	6,480	£47,350
1736 1745	75,520	7 8 6	560,106	7,552	56,010
1746 1755	98,790	7 8 0	731,457	9,879	73,145
1756 1765	169,699	7 6 6	1,243,045	16,970	124,304
1766 1775	264,273	6 14 6	1,778,337	26,427	177,833

Date	Ann. Tonnage	Date	Ann. Tonnage	Date	Ann. Tonnage
1726	5,000 Tons	1743	7,040 Tons	1760	15,780 Tons
27	6,700	44	7,230	61	17,004
28	6,800	45	6,700	62	16,054
29	6,870	46	7,000	63	17,898
30	6,900	47	4,900	64	21,489
31	7,000	48	6,000	65	16,774
32	7,290	49	7,200	66	21,251
33	7,000	50	9,400	67	18,502
34	6,000	51	11,000	68	23,671
35	5,240	52	12,050	69	26,655
36	8,000	53	13,000	70	30,776
37	9,000	54	14,000	71	27,896
38	10,000	55	14,240	72	27,654
39	11,000	56	16,000	73	27,765
40	5,000	57	17,000	74	30,253
41	5,500	58	15,000	75	29,950
42	6,050	59	16,700		

A

GENERAL TREATISE

UPON

MINERALS, MINES,

AND

MINING.

BOOK I.

CHAP. I.

Of the Origin and Formation of Metals and Minerals.

FROM the invifibility of the original caufes of Minerals and Metals, every fyftem and theory, framed to account for their production, muft be fpeculative and controvertible. The mundane theories of Burnet, Woodward, Whifton, De la Prime, Scheuzer, and others, though they have all their probabilities, are all liable to many objections. Indeed, to fearch into the fecret caufes of feveral appearances in nature that are evidently exifting, and obvious to our fenfes, both in her grofs and minute operations, requires fo much accurate labour, found learning, and folid judgment, that as it would appear prefumptuous in me to obtrude any particular theory of my own, I fhall only offer my opinion in the following fheets, with all imaginable deference to the judgment of the candid publick.

Though the ftupendous views we have of divine architecture, fill our fouls with admiration and aftonifhment at his power who framed the heavens, and laid the foundations of the earth; yet the minuteſt of his works, for their exquiſite ſymmetry and delicacy, are equal evidences of the boundleſs ſkill of the divine Artiſt, who hath furniſhed us with no leſs matter of meditation and wonder in the conformation and inſtinct of the moſt contemptible inſect, than in the attributed ſagacity and unweildy bulk of the elephant.

Well might the immortal naturaliſt ſay, "That in nothing "more is ſeen the workmanſhip of nature (God) than in "the artificial compoſition of theſe little bodies," which in his contemplation on the body of a gnat he ſo elegantly illuſtrates; "Ubi viſum pretendit? Ubi guſtatum applicavit? "Ubi oderatum inſeruit? Ubi verò truculentam illam, et "portione maximam vocem ingeneravit? Qui ſubtilitate pennas "adnexuit? Prælongavit pedum crura? Diſpoſuit jejunum "caveam uti alvum? Avidam ſanguinis, et potiſſimum humani, "ſitim accendit? Telum verò perfodiendo tergori quo ſpiculavit "ingenio? Atque ut in capaci cum cerni non poſſit exilitas, ita "reciproca geminavit arte, ut fodiendo accuminatum pariter "ſorbendo que fiſtuloſum eſſet." (Pliny.)

If Pliny had been acquainted with microſcopick diſcoveries, where would he have found words to expreſs his admiration at Dr. Hook's aſſertion; "That if a large grain of ſand was "broken into 8,000,000 of equal parts, one of them would "exceed the bigneſs of thoſe creatures, who were ſo exceed-"ing ſmall, that millions of millions might be contained in "one drop of water!"

If we deſcend from the ſurface of the earth, we ſhall likewiſe find in her bowels endleſs ſtores of foſſils, petrifactions, minerals, and metals, to ſupply mankind with the means and materials of every ornament and conveniency: in which we may, as through a glaſs darkly, behold the ſecret operations of him that worketh all in all, both in the heart of man, and in the bowels of the earth! "Great and marvellous are thy "works, O Lord God Almighty! In wiſdom haſt thou made "them all—the earth is full of thy riches!"

It is very probable that the nature and uſe of Metals were not revealed to Adam in his ſtate of innocence: the toil and labour neceſſary to procure and uſe thoſe implements of the iron age could not be known, till they made part of the curſe incurred by his fall: "In the ſweat of thy face ſhalt thou

"eat

" eat bread, till thou return unto the ground; in forrow fhalt " thou eat of it all the days of thy life." (Genefis.) That they were very early difcovered, however, is manifeft from the Mofaick account of Tubal Cain, who was the firft inftructer of every artificer in Brafs and Iron; and being the fon of Lamech, who was the father of Noah, muft have been fuch an inftructer Anno Mundi 1,200, or thereabout. Whether this is the fame perfon as in the Heathen mythology is called Mulciber, or Vulcan, who was the god of fubterranean fire, and efteemed the prefident over Metals, it is not effential to our purpofe.

It has been long difputed whether Metals are generated, or were all originally produced at the creation: whether they admit of germination, or augmentation, like animal or vegetable bodies, or whether they proceed from an accumulation and cohefion of metallick particles; or by what other means they were formed and produced.

The doctrine of the alchymift maintains, that they proceed from a certain Primum Ens, or firft feed of Metals, which they fay is a kind of moift vapour or Gas, that changes the earth and juices it meets with in a vein into a mineral body or fubftance; and thence converts the Minerals into Metals or Ores by a continued fermentation and elaboration in the Mines, caufed by the Archeus or heat that acts on the veins, as it proceeds from the center of the earth; it afferts alfo, that different Metals are produced conformable to the time and degrees of fermentation which the Mines have undergone; and partly by the purity and fuitablenefs of the veins, or the earth in them, which they fuppofe are as matrixes to contain and nourifh Metals in embrio; fo that in the fpace of a thoufand years, it feems, a Metal is generated and perfected de novo, according to the concurrent caufes, fuch as the impregnation of the Archeus, or the like. But this doctrine of Mineral fermentation is very properly denied to have any exiftence, by the accurate Boerhave, who, in his Hiftory of Fermentation, declares it to belong only to the vegetable kingdom; for he fays abfolutely, " This inteftine motion can be " excited in vegetables only;" and for Minerals, he does not remember that any fermentative motion has been obferved therein: fo that I think we may with full propriety exprefs what is meant in the term fermentation, by effervefcence, which different admixtures of Mineral particles may momentarily excite;

and

and which really conveys a ſeparate ſenſe and meaning, from the true natural operation of ferments.

Others will have it, that all Metals and Minerals were at firſt created in the very ſame ſtate and nature in which they are always found, without undergoing any kind of alteration. The moſt common opinion among the Miners in Cornwall is, that crude immature Minerals do nouriſh and feed the Ores with which they are intermixed in the Mines; and that the Minerals themſelves will, in proceſs of time, be converted into Ores productive of thoſe Metals, to which they have the neareſt affinity, and with which they have the greateſt intercourſe. This, however, is but the common opinion. Thoſe of moſt experience ſeem to have a contrary notion of the matter, and yet differ among themſelves. We apprehend the beſt and moſt plauſible reaſons that can be advanced, are thoſe which are neareſt at hand, are moſt obvious to our ſenſes, and are deduced from obſervation and experience; and therefore, without animadverting on the different opinions abovementioned, we ſhall proceed to communicate our own thoughts on this controverted ſubject.

It is reaſonable to conclude, that Metals were made and implanted in veins at or very ſoon after the creation of the world. Tin Ore will peculiarly evince the juſtneſs of this concluſion; for it is frequently found, in its richeſt and pureſt ſtate, in large ſpots and bunches in blocks of ſtone of the moſt hardened conſiſtence, ſuch as Granite, Elvan, and the like, which have been above the ſurface ever ſince the firſt induration of ſolids, have experienced no revolution, nor been water-charged with metallick particles, unleſs from the clouds of heaven. Perhaps it has been primarily ſo with moſt other Metals, as their uſefulneſs was diſcovered to man before the methods of ſinking deep into their proper niduſſes were at all known. In other countries, where Metals may be more generally diffuſed, it has probably been found as I ſay; and from the beginning, theſe metallick diſtributions may have experienced a decay and alteration by the action of the different elements upon them, according to their ſpecifick induration or laxity.

I have before obſerved, that Metals are ſubject to a degree of fluctuation, in common with all matter; and that they approach to, or recede from, their ultimate period, or degree of perfection, either quicker or ſlower, as they are of a greater

greater or lefs folid and durable frame and conftitution. In favour of this opinion, it is found, that the Ores of Copper and Lead, though rich and folid in nature, yet by a long infolation, or expofure to the fun and weather for fome years, lofe much of their Metal: and alfo, that thofe Mines which abound with a rich mature Copper Ore, do, near the furface, at leaft imme-diately over the body of the Ore, commonly contain a ruft, tincture, or fpume of Copper, refembling Verdigreafe; which feems to be an Ore in a declining ftate, being elevated by an effervefcence in the bowels of the Mine from that fulphureous body of Ore which often lies under it, and to which it did belong at firft, and was united with it, till fome intervening caufe occafioned fo vifible an alteration in the Ore of one and the fame Mine.

It feems to me that in every Metal there is a peculiar mag-netifm, and an approximation of particles fui generis, by which its component principles are drawn and united together, parti-cularly the matters left by the decompofition of the waters paffing through the contiguous earth or ftrata, and depofited in their proper nidus; till, by the accretion of more or lefs of its homogeneous particles, it may be demoninated either rich or barren.

That Ores, and even virgin Metals, are or may be formed in this manner, feems manifeft from a method now in ufe, of ex-tracting Copper from waters ftrongly impregnated therewith: Iron which has lain fome time in fuch water, is found on exa-mination to be greatly corroded, and to have Copper formed in its ftead, either adhering to the Iron, or funk to the bottom of the veffel, in form of ruft, and fometimes even in fmall grains of a complete metallick appearance.

This Copper and ruft on being fmelted with a reducing flux, fometimes produce above three-fourths of their weight pure Metal. The water generally ufed for this purpofe is that which is left by lotions of black Tin, intermixed with Copper, after it has been calcined in the proper furnace, commonly called a Burn-ing-Houfe. The Copper contained in this water, is kept in folution by an acid; and this acid having a greater affinity with Iron than with Copper, on the immerfion of Iron, quits the Copper to join with the Iron; by which means a precipitation enfues, in the manner juft mentioned. This procefs may at any time be evinced by the following experiment. Diffolve thin plates of Copper in Aqua-fortis, and you will have a clear liquor of a fine blue tinge: on applying to this thin plates of Iron, the acid, quitting the Copper, will precipitate it in the manner before defcribed, as Copper would have done by Silver, had it been firft diffolved in the menftruum; and as fixed alkali will do by the Iron, after it has diflodged the Copper.

From this we may reafonably infer, that water, in its paffage through the earth to the principal fiffures, imbibes, together with the natural acids and falts, the mineral and metallick particles, with which the different ftrata are impregnated; and meeting, in thofe fiffures, matters which have nearer affinities with the acid, of courfe difengages it, in whole or in part, from the metallick and mineral particles, which it had held diffolved; and which, on being fo difengaged, by the natural attraction between its parts, forms different ores, more or lefs homogeneous, and more or lefs rich, according to the different mixtures, which the acid had held diffolved, and the nidus in which it is depofited. The acid, now impregnated with a new matter, paffes on; till meeting with fome other convenient nidus, it lodges in that, and thereby acquires a frefh impregnation, perhaps at laft totally unmetallick; or, for want of meeting with a proper nidus, appears at the furface, weakly or ftrongly tinctured with thofe principles it had laft imbibed.

By means of thefe acids, the Miners are often put to an extraordinary expence for Brafs pumps inftead of Iron; for many of the Mines have water fo fully imbued with acid, that the Iron working-pieces, in which the pifton of the pump works, will be entirely corroded therewith in fix months; and a great expence and lofs of time will be incurred, if the pumps are not previoufly furnifhed with Brafs working pieces, as on them the acids, which are already faturated with kindred particles, have little effect.

Thefe, I prefume, are plain demonftrations: whence it appears, that Goffan, which is an ochreous Stone, ruddy, and crumbling like the ruft of Iron, much of which it really contains, is a proper nidus for moft kinds of Metals and Minerals; Iron having, even in this its mineral ftate, fo ftrong an affinity with the acids, as to decompofe them, when faturated with other Metals, Semi-metals, &c. on which decompofition, the precipitated matters become Ores of different kinds, and even virgin Metals, as before defcribed.

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In Mr. Gellert's tables of affinity, Zinc is indeed placed in the firft degree, and Iron in the fecond ; but this, which refers only to their metallick ftate, does not affect what I have above advanced of the mineral : yet, in the mineral, Zinc is fcarce ever free from Iron ; the vaft quantities of Black Jack which this county produces, being, by means of this mixture, rendered moftly unfit for ufe.

We have, indeed, feveral kinds of Goffans, from the different appearances of which, experienced miners form very ftrong and well grounded conjectures, of what they will produce when they come to be wrought : but more of this when I come to define the nature of Lodes, in refpect of the earth and ftones they contain.

The different alterations of fubftance before defcribed, are deemed by fome a genuine tranfmutation : but they carry the argument too far, who fuppofe that Minerals or Metals are entirely changed from one kind to another, as Mundick into Copper, Lead into Silver, Silver into Gold, &c. For when Metals or Ores do once arrive to their utmoft perfection, which probably they were endued with from the beginning, and which is always effential to them, though fubject to divers impediments and revolutions ; it is not eafy then to conceive, how they can by any means affume an entire alteration or renovation, fo as to be tranfmuted from one Metal to another, by any degree of elaboration in the earth.

If this tranfmutation was a fact in nature, from the divers alterations which we may reafonably fuppofe to happen in our foluble Minerals, fuch as Copper Ore for inftance, we might expect to meet with the moft perfect Metals in our Mines ; and our richeft Tin Mines, by the elaboration and melioration of them in the courfe of two thoufand years, might at this time be productive of Gold and Silver enough, to furnifh a fum ten thoufand times ten thoufand greater than our national debt. But the wifdom of God, for the benefit of his creatures, has ordained, that things of this kind fhould remain enfhrined in their own nature : and Tin, though united by a differminated quantum of Gold, will not part with its noble cement, notwithftanding the chymical analyzations of an illiterate impoftor to extract a pound of Gold from every block of Tin. No, the goodnefs of Providence has fixed unalterable limits to the perfection of each particular Metal, to render the whole of greater fervice ſervice to mankind ; the inferior Metals, Iron eſpecially, being of more general utility than Gold, Silver, and even precious Stones.

If it be ſaid, that the impurities of the earth in our Mines, is the cauſe that nature is debilitated and fruſtrated in her endeavours after tranſmutation ; it is anſwered, that, notwithſtanding this impediment, ſuch a long elaboration and maturation in the earth, in ſo great a ſeries of years, would neceſſarily and inevitably exalt the baſe Metals into ſo high a degree of purity and goodneſs, that they would, by this time, be greatly enriched with Gold or Silver ; and though they contain Stones and Earths of various colours and degrees of purity, yet there is no eſſential difference between them, from one containing a nobler Metal than another ; which would ſcarcely be the caſe, without ſome ſtronger evidence of exaltation, notwithſtanding all the oppoſition that nature could meet with in the Mines, provided ſhe was endued with a power of converting the baſe Metals into thoſe of a ſuperior kind.

We may likewiſe conclude from the premiſes, that the opinion of thoſe, who hold that Metals in the earth continue in the ſame ſtate as at firſt, is erroneous ; becauſe the migration and egreſs of Metals and Minerals, is obvious enough in the inveſtigation of Mineral Spaws or Springs.

Many of our Mines furniſh Stones, perhaps of but an ounce weight, in which may be diſcerned the pure Ores of Tin and Copper, Copper and Lead, Zinc or Mock-lead, and Mundick, each in a ſeparate ſtate from the other, (by the intervention of Goſſan, Cal, Flookan, Spar, and Chryſtal.) How ſhould this natural claſs and order of Metals, &c. be effected, but by the agency of water to bring, and the power of attraction to arreſt, ſuch and ſuch particles, and depoſit each in its proper matrix or nidus ? May we not, therefore, ſuppoſe, that Mines which are very rich at one given time and place, may in ſeveral centuries after be impoveriſhed in that place ; and other parts of thoſe Mines, which were then barren, may be now plentifully ſtored with Metal, according to the ſolution and tranſmigration of their reſpective principles, which are depoſited in ſome other magnetick nidus ; whoſe power of retention, in proceſs of time, may be again decayed, thoſe principles again depart, and again be arreſted ad infinitum ? This may account for the uncertain diſtribution of Ore, in one and the ſame Lode ; which may be very

very rich in this age, and in the following not worth any further purfuit. And this may alfo be the caufe of the old Huel Virgin's producing near half a million fterling; and the eaftern Huel Virgin's never yet producing three hundred pounds, though of feventy fathoms depth, with eight thoufand pounds charge upon her, and ftill within forty fathoms of a gulph of Copper Ore in the fame Lode.

This hypothefis, which is formed on my own obfervation and judgment of Metals, may not be relifhed by thofe, who have adopted the ancient opinion of the production of Metals and Minerals by vegetation; nor by thofe, who fuppofe Metals to continue always in the fame ftate. But though I am not fond of fingularity, I cannot help diffenting from the common traditions, for the reafons I have given; which, I hope, are fo plain and natural, as to fatisfy the reader, that there is no need of having recourfe to the center of the earth for a folution of this matter. In inquiries of this nature, every one has a right to be guided by his own experience and judgment. And though the fubject, at beft, is fo obfcure and difficult, that it can never be clearly put out of difpute, yet I think, I have evidenced the propofition upon which I firft fat out; namely, that all matter is fubject to rotation and viciffitude, to continual different modifications, improvements, progrefs, decay, and reformation; and that, at the fame time, the primeval principles and particles thereof remain naturally the fame in fome part of the univerfe, unlefs difunited by the contrivance, and for the ufe of man, on whom all things here below have been bountifully beftowed by him, who is the Author and Giver of all good things both in heaven and in earth.

CHAP. II.

Of Water, the Vehicle and Cement of Metals, Minerals, Stones, &c.

I SHALL now endeavour to confirm what has been faid, by examining what the effects are, that proceed from the caufes I have fuppofed: and to fhew the propriety of my fuggeftions, it will be neceffary to examine into the properties of Water, as univerfally admitted by the moft approved writers on that fubject.

Next to Fire, Water is the moft penetrative of all bodies; by which quality it is fitted to enter into the compofition of all Animals, Vegetables, and Foffils: by this, alfo, joined with its fmoothnefs, it is fitted to convey the nutritive matter of Foffils, Stones, Minerals, and Metals; paffing fmoothly on, it never ftops the pores, but leaves room for fubfequent fupplies. Yet Water, which fo eafily feparates from moft bodies, firmly coheres with fome, and binds them together in the moft folid maffes. It is by the glutinous nature of Water alone, that our houfes ftand: for take Water out of wood, and wood becomes rotten; out of brick, tile, and ftones, and they become duft. It is evident that Water fubfifts in Metals; for the filings of Tin, Copper, and Lead, yield Water plentifully by diftillation. "All Foffils, and even Metals themfelves, are capable of dif-"folving in Water, and indeed are naturally mixed therewith; "and this holds of all concreted faline, vitriolick, and metal-"lick juices, of which Water makes a principal part, ferving "to dilute, move, change, increafe, and incorporate them "with each other." (Boerhaave.)

As it is evident, therefore, that the Waters flow from the circumjacent earth, or ftrata, into, and through the Mines, from one vein or fiffure into another, and fo on throughout in conftant circulation, till they are difcharged upon the furface, for their ultimate conveyance into the fea; fo they ferve as a vehicle to protrude and convey the acids, falts, and minute loofe particles of Ore or Metal they meet with, into their proper matrixes or veins, where they are depofited by the decompofition of the acid, and attracted by the Metals, Minerals, or Juices, to which they have the neareft affinity; and in procefs of time are accumulated into large heaps or quantities, while the other earthy or ftony parts of the vein are carried away by the ingrefs and egrefs of the pervading waters: and thus the Ores, or Metals, are continually complicated, congealed, and cemented, by the decompofing and magnetick quality in the Mines; to which the agglutinating petrifying nature of the Waters, doth not a little contribute.

But if thefe properties in the Mines be enervated or deftroyed, then their particles will be difunited and feparated fo fmall, as to render them capable of being protruded and forced away by the Waters into the contiguous ftrata; while the impurer parts of other places are impelled by the Waters into the Mines, where they fubfide or lodge, in the room of the Ores or Metals that

were

were thence difplaced. We are fenfible that the Loadftone, which has fo wonderful an attraction, may lofe its virtue; and therefore it ought not to be thought ftrange, that Mines fhould be fubject to the like alterations, from the intervention of accidental caufes.

The confideration of the nature of mineral fpaws and fprings, will fenfibly inform us, that there is fuch a continual percolation of Minerals and Metals, or their falts or principles, through the pores and channels of the earth; and the goodnefs and providence of God are paternally apparent in their falubrious effects upon the impaired conftitutions of mankind. But there is a far greater difplay of his benevolence to us in particular; for this town and neighbourhood are entirely fupplied with pot Water from mineral fprings, and thofe of the moft deleterious miafma: nay, for the moft part, our Water for culinary ufes, is taken up at the low-floven, or tail of the adit, immediately where it difcharges from thofe Mines which are not working; and have run half a mile or more over a bed of Copper, Mundick, and every other congeries of mineral poifons. This is a fact fo notorious, that I can produce many thoufand atteftations to confirm my affertion. To what caufe fhall we afcribe the falubrity of Pednandrea, and Huel-Sparnon Waters? Thofe Mines have been wrought at a confiderable depth by the power of three fire engines, and have produced vaft quantities of Tin, Copper, Mundick, and fome Lead; yet, at this time, when thofe Mines are not working, and the Water is clear, we ufe it for all purpofes indifcriminately, without the leaft tinge, or the leaft incruftation upon our houfehold utenfils; and in twenty-four years acquaintance with the practice of medicine, I have not met with any one patient, whofe diforder I could attribute to the moft trifling unwholefomenefs in our Mine Waters.

If the reader will advert to the true caufe of thefe different effects in one and the fame fluid, he may find it in what has been before faid; and will prefently join in opinion with me, in the properties attributed to Goffan Lodes: and this will be a further demonftration of the decompofition of thofe Waters into their primitive purity and innocence, by contact with this ferruginous medium. Again, as a proof of a proof, feveral Mines, whofe adits are fo much deeper as to be under the Goffany bed of Ores, do produce Water fit for no ufe but driving mill or engine wheels. Such Water is quite noxious, and palpably vitriolick to the tafte, particularly at the Mines of North-Downs,

Downs, Chacewater, and Huel-Virgin. I know that ſome may ſay, if this be the caſe, theſe Mines will be again renovated. Probably this, in a certain degree, will be the caſe: but let it be remembered, that where the nidus with the decompoſing matter is taken away, the Water from the circumjacent ſtrata, inſtead of percolating through the vein, falls into a congregated fluid of its own kind. Indeed, where any of the vein is left in whole, as we call it, we ſee no reaſon why it ſhould not have the ſame effect there as formerly; nay, we are of opinion, that where a Mine has been wrought till the Lode has proved barren in quality, and is left off from extreme poverty, if the vein continues, and is endued with the ſame decompoſing and attractive qualities as the part formerly wrought originally might have been, ſuch Lode may probably be converted into Ores, by the Water now percolating through it, and ſaturated accordingly.

The Miners often feel a palatable difference in Water under ground, at a great depth; for if they taſte a clear ſtream of Water, as it flows down upon the walls of the Lode, it is either very cold or almoſt lukewarm, or inſipid or ſweet. In Copper Mines particularly, we ſometimes find the Water full as warm as new milk in one part of the mine, while it is very cold in another; nay, in ſeveral of theſe, particularly in Huel-Muſick and Huel-Roſe, the writer has ſtood with one foot in the warm, and the other in the cold Water, and has divided and diverted them different ways. In the former of theſe Mines, the diſcovery of this warm Water, has always immediately preceded a conſiderable enlargement of the Lode, and richneſs of the Ore. In the latter, the cauſe is not ſo abſolutely determined; as the Lode from which it is known to proceed, has not been diſcovered at that depth; but where it has been ſo, it greatly abounds with ſulphureous Minerals.

On the other hand, the Water which flows through a bed of Tin, is generally very fine, ſoft, and inſipid; eſpecially if the Lode or ſtrata are of the Grouan or Elvan kinds, and the Tin rich in quality and homogeneous. Our clean Pryan Tin Lodes likewiſe yield a ſoft alkaleſcent Water, that, I am ſatisfied, would be of ſingular ſervice to all perſons afflicted with acidities in the primæ viæ.

Springs are either temporary or perennial: ſome ſay, that they originate from vapour, rain, or dews, collected on the ſides fides of mountains, and are thence commiffioned into the bowels of the earth, in form of fprings; others, that they proceed from the deep abyfs; and others, that they are filtrations from the fea, into which all the rivers run, as into the place from whence they came, per modum circulationis. For, "all "the rivers run into the fea, yet the fea is not full; unto the "place from whence the rivers came, thither they return again."

The theory of Meff. Marriotte and Perault, that fprings have their origin from rains, hath been examined and confuted by Mr. de la Hire. Dr. Halley's hypothefis, of their being produced by vapours, though the moft popular, is in a manner overturned, in our opinion, as well as the former, by Mr. Derham's perennial fpring in the parifh of Upminfter, and various others in different parts. Of thofe who have mentioned that, which we conceive to be the only true origin of perpetual fprings, The Ocean, none have, to our knowledge, affigned the quo modo or proper caufe; and therefore leave it undetermined, or rather give up their unfupported argument in favour of Dr. Halley's more plaufible and commonly received, though more erroneous, hypothefis, of its being effected by the condenfation and precipitation of vapours and dews from the tops of mountains.

The ftrefs of our argument and the novel part of our hypothefis, is, that in the formation of perpetual fprings, they not only derive their Waters from the fea, by ducts and cavities running from thence through the bowels of the earth, like veins and arteries in the human body; but that the fea itfelf acts like a huge forcing engine, or hydraulick machine, to force and protrude its waters from immenfe and unfathomable depths, through thofe cavities, to a confiderable inland diftance.

One of the hydroftatical laws of fluids, being, that their preffure is in the ratio of their perpendicular altitudes, how very great, how immenfe muft that preffure be, in the unfathomable parts of the fea! and, indeed, in thofe parts, which, as Varenius affirms, have been fathomed to the depth of four miles and a half! Only conceive (if poffible) a forcing engine, or the beft hydraulick machine, acting with a force equal to this immenfe preffure, upon a body of water, in order to carry it to any diftance whatever, or raife it to any conceivable height! Imagine then, with what inexpreffible force the water from fuch a preffure, muft be protruded through thofe cavities, ducts, and hollow paſſages, from the bottom of the ſea, through the bowels of the earth, to various parts of its ſurface, where they diſcharge themſelves, as through ſo many tubes or pipes, and form perpetual ſprings; ſome riſing, either from a duct of leſs perpendicular depth, where the preſſure is not ſo great, or otherwiſe more perpendicularly than others; conſequently, in either caſe, at a leſs diſtance from the ſubaqueous mouth of the duct; whilſt others, running more horizontally, or derived from a greater depth, where the preſſure is proportionably ſtronger, or, perhaps, from the duct tending for a conſiderable length towards the center of the earth, are forced to a greater inland diſtance, in the confined tubes or veins of the earth, before they emerge to the ſurface, which we apprehend they do from various orifices and branches, like capillary tubes from a principal artery: the preſſure of the fluid acting in this inſtance, as in all others; and the immenſity of that preſſure in the ſea ſeeming to juſtify our calling it a huge forcing engine, and comparing it to an hydraulick machine, whoſe power we can eaſily conceive to be ſufficient, from the convexity and globular form of the ſea as well as the land, to force its Waters through the aforeſaid capillary tubes to the tops of the higheſt mountains, even without the aid of attraction, which, not improbably, may in ſome caſes contribute ſomewhat towards their aſcent.

That which gave birth to our conjectures, and led us into theſe reflections, was the conſideration of the Caſpian ſea, as having no viſible outlet; moſt of whoſe rivers, which diſgorge themſelves into that grand reſervoir, we conceived as deriving their origin from the ſea itſelf, being forced, by the preſſure of the atmoſphere and watery fluid, through ſubterraneous ducts and channels to certain diſtances, where they emerge in ſprings and bubbling fountains; and increaſing as they approach nearer to the ſea, by the acceſſion of other Waters from other ducts, are ſwollen into conſiderable rivers of freſh Water, affording a conſtant ſupply to keep that grand reſervoir "without o'er-"flowing full;" which freſhneſs, we conſider, and ſuppoſe it is generally conſidered, as effected by the ſalt water being filtrated and ſtrained through a conſiderrble body of earth in its paſſage from the ſea to the fountain head. As a juſtification of this ſuppoſition, we beg leave to mention, the brackiſhneſs of thoſe ſprings, which is frequently complained of near the ſea coaſts; and which is undeniably occaſioned by their vicinity to the ſea, whoſe Waters are not filtrated through a ſufficient body

of

of earth, totally to deftroy their faltnefs, and render them quite frefh.

We do not, however, fuppofe, that all the rivers which empty themfelves into the Cafpian or any other fea, are always derived from that particular fea into which they return: for inftance, we conceive the head of the Wolga river to be more probably derived from the Frozen-fea, to which its fource is much nearer than to the Cafpian-fea; and which feems even neceffary, in order to fupply that quantity of fluid, which muft be conftantly evaporating from its furface, for the fupply of dews, rains, &c. for an extenfively furrounding country. Again; it is probable, that the Nile takes its fource from the Eaftern-ocean or Red-fea, rather than from the Levant or Mediterranean into which it runs: alfo, that the river Amazones, takes its rife from the Pacifick-ocean, and not from the Atlantick-ocean into which it flows: and fo of various other foreign rivers, which, though they may take their origin as we have here fuppofed; yet we further fuppofe, that as they arrive nearer to their mouths, they may be and are confiderably increafed, and receive large additions, by the like ducts and channels, from that fea likewife into which they run.

To illuftrate this hypothefis, we fhall mention one inftance more in our own country, of the river Tamer, which divides Devonfhire from Cornwall; whofe head rifes, we fuppofe, from the Briftol-channel, within five or fix miles from Hartland-point; and after running near an hundred miles due fouth, empties itfelf into the Englifh-channel at Plymouth; whilft the river Torridge, which rifes on the fame common, and within the diftance of a few cloth yards from the Tamer, after a courfe of upwards of fifty miles, difgorges itfelf again into the Briftol-channel in Barnftaple-bay, not twenty miles N. E. from its head.

Let us adduce the rife of thefe two rivers, as pofitive proof againft Dr. Halley's ingenious hypothefis. "Their heads are "two perpetual fprings within a few yards of each other, on the "pretty level fummit of a vaft high common, one of the higheft "in all the neighbourhood; where there are no rocks or crannies "for the vapours or dews to gleet down by, nor any mountains "or caverns above it to collect a body of water; nor any one "circumftance favourable to his hypothefis." Letter from Chriftopher Gullet, Efq; of Exeter.

The

The Waters with which our Mines abound, are derived both from temporary and perennial fountains; and are very properly diftinguifhed with us, by the names of Top and Bottom Water. Shallow Mines have very little Water, more than comes from the furface; and it is temporary, according as the feafons vary; fo that, without a competent power to draw out the Water from the workings, the adventurers are generally obliged to ftop them, or "Knock the work," as the phrafe is, foon after the autumnal equinox; otherwife, which is frequently the cafe, they expofe themfelves to a great expence, difappointment, and lofs.

Our very deep Mines are fubject to Water from both the fources before mentioned; for in the drieft feafons we know of, they have a conftant ftream ab interno, which requires much expence and addrefs to keep under: but in the depth of winter, when all the earth is drenched as it were with moifture, we are vifibly affected by the concurring ftreams both of Top and Bottom Water; notwithftanding all precautions are ufed, to take up the fuperficial ftreams, by launders or grooves cut in the walls or fides of the Lode, to convey them either into the adit or tye lift of pumps, by which the burthen is eafed for the engine, and the bottoms are freed from fo much Water.

The deepeft of our Mines are not much affected by the influx of Top Water, before the depth of winter; as it takes till that time, to fill the interftices of the earth or ftrata, and protrude its redundant ftream to the deep bottoms. Our moft experienced Miners will fay, that "A dry eafterly wind raifes the "fprings;" but although it may appear fo to our outward fenfes, yet a little application to the folution of this phenomonon, will fhew the conclufion to be falfe.

During three parts in four of the year, the wind blows from the intermediate points of the weft and the fouth; and coming over a large tract of the Atlantick-ocean, and confequently fraught with much wet, difcharges its moifture, as foon as the current of air, which fufpended the clouds, is diminifhed and broke by the cliffs and hills. It was an obfervation made by our Saviour, that the weftern winds brought rain in Judæa: Luke xii. 54. The fouth wind coming from the coaft of Africk, had the fame effect in the Adriatick: Horace Lib. i. Ode 3. The weft wind is often fo fierce and raging after acquiring ftrength in the Atlantick-ocean, that it is fcarce conceivable

conceivable with what fury it attacks the coafts of Britain ; and it is very well known, that it commonly blows above half the year (which was alfo obferved by Julius Cæfar) and that very violently, efpecially in the autumn ; whence our Michaelmas ftorms and rain. Philos. Trans. No. 352.

In thefe inftances, the frequent rains are the confequences of winds, paffing over a large tract of water ; and this may lead us to the reafon, why the winds come fo much from the fouth-weft in Cornwall, that we have known them blow from that quarter the four laft months of the year, almoft without intermiffion, attended by violent floods of rain, which took all the time before mentioned to arrive at the deep bottoms ; about which feafon, at Chriftmas, or very foon after, the wind fhifts to the oppofite point of the compafs, and generally brings along with it the little froft and cold this country is fubject to ; mean while, the Waters are determined to the bottoms of our deep Mines, merely by the time they have had to fink down through the earth. The impatient obferver wonders at this flow defcent of the Waters ; and when the wind fhifts to the eaftward, he very injudicioufly attributes the effect to a wrong caufe.

We confefs, the above feems to us a very natural and plain explication of the affair ; but as we have not that deference for our own opinion, as always to prefer it to others, we are ready to acknowledge ourfelves open to conviction, if a better reafon fhall be advanced at any future time. And as a hint to our readers, we defire they will confider, how far the denfity and confequential preffure of the atmofphere may contribute to this appearance more than a hundred fathoms underground. It is true, the Mines are continually fraught with a kind of warm vapour, which may be feen to arife from every fhaft, when the air is cool, clear, and denfe ; and it may be fuppofed, that, as it afcends through the natural and artificial outlets of its womb, it is more or lefs condenfed by the external air, in proportion to the rarity or denfity thereof. But if this folution appears plaufible to fome, we defire to be informed, why this fhould not be more apparent, when the wind blows from the north ; and why this vapour, if not of the dry kind, fhould not be condenfed in the fhafts and gunnies (hollows) of a Lode, after the manner of rain, as other vapours are, and, therefore, be as diftinguifhable in its production, as in its exiftence ?

 From

From the foregoing proofs, that rain Water penetrates to the depths of the earth, we may be fatisfied, that the opinion of De la Hire, Calcott, and others, who fay, rain Water does not fink two feet below the furface, is altogether erroneous; for if it does not enter into the bowels of the earth, what elfe fhould occafion fo vaft an increafe thereof, at, or foon after, its difcharge from the clouds? So apparent is this fact, that if the great increafe and collection of Water from the heavens, before mentioned, be obftructed in its circulation, and collected into large bodies, by the peculiar matter or form of its recipient, it may, and has many times appeared to be the caufe of local earthquakes; which, we apprehend, may proceed from the Water of higher grounds, that gets underneath a flimy vifcous earth or clay, until the force of the confined Water moves it upward, and carries the earth along with it in its paffage and irruption; of which we may produce an inftance, at Kappanihane in Ireland, A. D. 1697; another of Pilling Mofs, in 1745; and a more recent one, in the late accounts we have had, of Solway Mofs in North-Britain:

——— As if on earth,
Winds under ground, or Waters, forcing way,
Side-long had pufh'd a mountain from his feat,
Half funk with all his pines.

MILTON.

As for thofe earthquakes, which are more general, tremendous, and deftructive; it is probable they are caufed by the combination of different falts, juices, fulphur, or fome other inflammable matter, that rarifies and agitates the air, in the deep caverns of the earth; whereby a convulfion is caufed, which fometimes breaks out in flames at the furface; and fometimes fhocks and gives the earth a tremulous motion, without any vifible fire, perhaps for want of fufficient matter to ignite. For, if you add twenty pounds of fulphur to twenty of iron filings, and mix thefe with water, fo as to form a pafte; in fix or feven hours after they have been buried a foot and half under ground, the earth will begin to tremble, crack, and fmoke, and fire and flame will burft through; fo that there wants only a fufficient quantity of this matter, to produce a true Etna. If it was fuppofed to burft out under the fea, it might occafion a new ifland: and we believe Delos, Rhodes, and fome other iflands were produced by the fame, or fuch like fubmarine volcano. (Pliny) An ifland in the Archipelago on the coaft of Natolia,

Natolia, in 1707; another among the Azores, in 1720; and four iflands in a lake, in the Manilla, A. D. 1750; are productions in the prefent century, from the fame caufe. Dr. Worthington advances, "That the fole caufe of the formation "of mountains, was an univerfal earthquake."

The immenfe congregation of Iron, Sulphur, and other combuftible materials, with which our mining diftrict is fo replete, would naturally incline us to believe our fituation more obnoxious to fubterranean throes, than any other part of Great-Britain. But, by the mercy of our Gracious Preserver, we have hitherto felt nothing peculiarly to alarm us, on account of our fituation. Many are of opinion, that our numerous fhafts, adits, and other apertures, are the principal outlets, through which the mineral effluvia of our Lodes exhale and efcape, without prejudice to the lives and fafety of the inhabitants.

Another prodigious, general, and effective caufe of earthquakes, is an electrick æther in the atmofphere, according to the opinion of the learned Dr. Stukely; and from this force, extended to a confiderable diftance, through various fubftances, of different textures and denfities, we may attribute the deftruction of no lefs than thirteen great and noble cities in Afia Minor, in one minute's time, in the year of our Lord 17. Another earthquake in Peru, anno 1586, extended 900 miles; and we may add that memorable earthquake in our own days, upon the 1ft of November 1755, which deftroyed Lifbon, and was felt over almoft half the habitable globe.

We may apply either of thefe caufes, under fuch certain fituations and circumftances, as may incline our judgment to preponderate. But may not all of them operate for the fame effect? We think they may: and who can fay, it is not fo? For with Job we may fay, "Lo, thefe are parts of God's ways; "but how little a portion is heard of him? And the thunder "of his power who can underftand?" Omnipotence being the directing caufe, all things are equally accomplifhed by the natural inftruments of his power: and when we hear the thunder of his voice, and fee the mightinefs of his power, the dreadful, though partial convulfions, of an angry, yet merciful God; ought we not to meditate upon the hitherto harmlefs, though alarming tokens we have had of his indignation, tempered with love? Of all the natural warnings of his difpleafure, thofe of earthquakes are moft terrifick; coming like a thief in the night, when

when the ſons of men know not of it! We may flee from the peſtilence, the famine, and the ſword; we may avoid the dangers of the ſea, and provide againſt fire; we may ſecure our habitations from lightening, tempeſts, inundations; we may, by the aſſiſtance of ſkilful applications, and the wiſdom of the phyſician, baffle the attacks of diſeaſe, to the prolongation of our lives. But no flight, no prudence, no philoſophy, no delay, can obviate this deſolation: for, it is as the preſence of God! How thankful then, ought we to be! how humbly ſhould we walk before him, who hath hitherto ſpared us, in the midſt of his judgments! O Lord God; for the abundance of our ſins, thou art greatly to be feared; and yet we ſee that in great mercy, thou preſideſt over all thy works!

Though it is remarkable, that the Water of a Mine, at or near the ſea cliffs, is very eaſy and ſmall, eſpecially when the Mine is ſunk under low Water mark, or works under the ſea; yet it is abſolutely certain, that it is leſs in proportion to the ground diſcovered under the level of the ſea, than above. How this ſhould be, is one of the moſt puzzling queſtions that can be put to the Miners, who, to a man, ingenuouſly confeſs their ignorance of the true cauſe of it. The gentleman and the philoſopher are equally at a loſs to account for this fact, except Mr. Bennallack, who ſays, "That in the places where he has "had opportunities of judging properly, the only apparent "cauſe is, that the ſtrata being more compact, and conſe-"quently more free from thoſe ſundry kinds of fiſſures, which "the Miners in general call Caſes, there are not the ſame con-"veyances for the Waters of the ſurrounding country to flow "into the Mine." In Huel-Towan in the pariſh of St. Agnes, where they are not many fathoms under low Water mark, the facts of the Water being leſs, and the ground more compact, are inconteſtible; nor, in that place, does any other matter appear conducive to it. We believe this may be one natural cauſe in ſome particular places, but it cannot be always ſo; and we likewiſe believe, that there may be other contributing matters, which may be different, in different ſituations. We will have reourſe to the moſt ſimple and plain enquiry into the form and texture of the earth, in the ſolution of this phenomenon, diſtinct from our knowledge of the preſſure and gravity of fluids: but before we proceed, we beg leave to illuſtrate our ſubject, by a very remarkable hiſtory of a caſe in point.

The Mine of Huel-Cock in the pariſh of St. Juſt, is wrought eighty fathoms in length, under the ſea, beyond low Water mark; and the ſea, in ſome places, is but three fathoms over the back of the workings; inſomuch, that the Tinners underneath hear the break, flux, ebb, and reflux of every wave, which, upon the beach overhead, may be ſaid to have had the run of the Atlantick-ocean for many hundred leagues; and, conſequently, are amazingly powerful and boiſterous. They alſo hear the rumbling noiſe of every nodule and fragment of rock, which are continually rolling upon the ſubmarine ſtratum; which, altogether, make a kind of thundering roar, that will ſurpriſe and fearfully engage the attention of the curious ſtranger. Add to this, that ſeveral parts of the Lode, which were richer than others, have been very indiſcreetly hulked and worked within four feet of the ſea; whereby, in violent ſtormy weather, the noiſe overhead has been ſo tremendous, that the workmen have many times deſerted their labour under the greateſt fear, leſt the ſea might break in upon them. This proximity of the ſea over the workmen, without their being incommoded by the ſalt Water, is more wonderful, than the account which Dr. Stukley gives, of his deſcending into a coal pit at Whitehaven one hundred and fifty fathoms deep, till he came under the very bed of the ocean, where ſhips were ſailing over his head; being at that time, deeper under-ground by the perpendicular, than any part of the ocean between England and Ireland. In his caſe, there is a vaſt thickneſs of ſtrata between the Mine and the ſea; but, at Huel-Cock, they have only a cruſt between, at moſt; and though, in one place, they have barely four feet of ſtratum to preſerve them from the raging ſea, yet they have rarely more than a little dribble of ſalt water, which they occaſionally ſtop with oakum or clay, inſerted in the crannies through which it iſſues. In a Lead Mine in Perran Zabuloe, formerly wrought under the ſea, they were ſometimes ſenſible of a capillary ſtream of ſalt Water, which they likewiſe prevented by the ſame means, whenever they perceived it.

Now, a very large proportion of our Mine Water is temporary; and, as I have ſaid before, is denominated Top Water, which in great part ſinks into the Mine immediately where it falls, by the peculiar looſe texture of ſtrata where Mines are, which muſt be cavernous and fiſſured, to conſtitute and form thoſe receptacles of mineral particles called Lodes, and their lateral branches: conſequently, the ready acceſs of this Top Water, muſt be very ſenſibly perceived by the Miners; and more efpecially muft the difference be feen, when compared with a part of the fame Mine under the fea, entirely free from fuch Water. The fubmarine ftrata of our Mines, muft be totally impervious to any Waters, which fall into the fea. It cannot be otherwife. So that fuch parts of the Mines, are quite free of any Water locally above them.

The next paradoxical confideration that occurs, is to account for the abfence of the fuperfluent falt Water, from the fubmarine workings.

We have obferved a kind of flime or mucus upon fome marine ftrata, which is fo glutinous as to fill up every pore and cranny of the rock that is covered with it. This glutinous flime, we take to be a marine foil or earth, for the vegetation of grafs, ore weed, and other fea plants ; the fea is replete with it : every fhip at the end of a long voyage has her bottom covered with it, and a marine grafs vegetates therein. This vifcous matter thickens by degrees, as if purpofely defigned to hinder the Water from penetrating into the earth ; which it moft effectually does, according to my judgment of the matter. Upon a rough beach, this flime may not be equally depofited, by means of the conftant friction of rocky fragments under the action of the tide ; and other parts may be covered with loofe fand and pebbles, which afford no bed or reft for this foil. In fuch cafe, it penetrates through the furface, and finds a quiet depofitory, in the fmall clefts and interftices of the ftrata, below the force and action of the fea ; and in time, probably, incruftates and fills up thofe very minute fiffures, with a petrifactive gluten, if it is at all charged with fuch principles ; and we have neither theory or reafon to diffent from that opinion, as we think it muft partake of every principle which is foluble by Air, Water, and Salt.

Thus have we demonftrated, that Top Water does not fpecifically defcend into the Mine where it falls upon the fea, and confequently that part of the Mine cannot be incommoded thereby like other parts ; and that the minute pores and fiffures of fubmarine ftrata are almoft totally impenetrable by falt Water, through means of the petrifactive tenacious gluten, with which they are fmeared. The facts, added to the compact, or clofe conformation of ftrata in fome parts of the earth under the fea, will ferve, as we prefume, for a proper folution of this difficult problem.

That

That there is a petrifying quality in the earth or its juices, is manifeft to thofe who are converfant in Mining, and confider the nature of the Stones which are dug out of the ground; for they frequently meet with large folid rocks, compofed of feveral fmall Stones united together, of different forms, colours, and properties, with refpect to the fame individual Rock or Stone; which is a manifeft indication, that its different parts were originally loofe and diftinct from each other, until they were conjoined into an entire folid mafs, by fomething of a petrifying principle, which cemented them together. It is more than probable that Stones, like Salts, and moft Foffils, are the productions of a fufpended lapidifick matter in a fluid, which gradually hardens into Stone, by the evaporation of its finer parts.

Mons. Tournefort obferves, "That in the famous labyrinth "of Crete, feveral perfons had engraved their names in the "rock, of which its walls are formed; and that the letters fo "engraven, inftead of being hollow, as they were at firft, ftood "out from the furface of the rock." This can no otherwife be accounted for, than by fuppofing the cavities of the letters filled infenfibly with matter iffuing from the fubftance of the rock, even in more abundance than was needful to fill them. Letters cut hollow in a living rock of Limeftone, fill up, in a courfe of years, with fpar; and what were made in Creux, are found in Relief. This has been feen in Gothland, by the eminent Swede. The fpar ftands higher, as the time is more diftant; and has been feen, in fome places, a quarter of an inch above the level of the furface. (Hill)

Thus is the wound of a knife healed up, much as the fracture of a bone is confolidated, by a callus formed of the extravafated nutritious juice, which rifes above the furface of the bone. Such cicatrixes have been obferved to be formed on other Stones, which were reunited, after they had been accidentally broken. The many inftances we have of thofe cicatrixes in Granite or Moorftone, upon the furface of every karn or rocky hill in Cornwall and Devon, will clearly put this matter out of difpute; as our Stone-mafons always chufe fuch for fplitting in the very cicatrix, which generally is about a quarter of an inch above the other fuperficies of the ftone; and fplits with more eafe, than any other part of the fame block, becaufe it was before feparated, and had been again reunited by its petrifactive gluten. Hence it is manifeft, that the fame juice which nourifhes them, ferves to rejoin their parts when broken. We find, that Water is fo full of ftony matter, and fo ready in part to turn into Stone, that it fills every crack and crevice of the moft folid rocks with Stone of the moft pure kind, Spar or Chryftal. If Water contains a quantity of ftony matter, then Water is able, in fome flow way and in the courfe of nature, to diffolve this ftony matter, though we cannot make it do fo in any of our operations. If Water can diffolve ftony matter, Water may take it out of one place of the earth, and carry it to another. It will perhaps appear, that the original power of encrufting and petrifying lies in the earths and clays themfelves, a thing few have thought upon; and that the Water ferves as a vehicle to carry the ftony matter out of one place into another. All this being underftood, it feems natural to fuppofe, that not only the petrified fubftances found in the earth in fome places, but even the beds of Stones themfelves, owe their origin to thefe particles contained in the earth, and to the agency of Water, which can diffolve, remove, difperfe, feparate, and bring them together again in various forms and combinations. If Water can diffolve thefe particles of ftony matter, Water can in the fame manner keep them fufpended for a time, and let them gradually feparate and congeal afterwards. Water, therefore, can act, when it is thus loaded with particles, as a cement or agglutinating liquor to bind them together, or to introduce changes in them. For inftance, Water can fill the pores of clay; and if fuch Water fill the pores of a bed of this earth, and afterwards draining gently away, leave that ftony matter behind, it does, in that cafe, cement that bed of clay into a bed of Stone. (Owen).

This petrifactive quality, which ferves to conjoin and cement Stones together, we muft allow capable of inclofing, within itfelf, fundry extraneous bodies, which it may be in contact with, fuch as bones, fhell-fifh, and many other things, of which natural hiftory has given us fuch very ftrange accounts. I fhall add a particular domeftick inftance, of which we have been very credibly informed: namely, that fome few years fince, at this town of Redruth in Cornwall, fome labourers being put to clear and level the ftreet for a pavement, they found a piece of hard Stone in the ground, with abundance of common fmall pins of Brafs, interfperfed in and throughout the Stone, in fuch manner and form, that all thofe who faw it afterwards, were convinced, it was not done artificially, but that the Stone was formed and produced by petrifaction, fubfequent to the time the pins were dropped into the ground. Dr. Plot, in his Natural Hiftory

Hiftory of Staffordfhire, fays, "That near Newcaftle under-"line, there was found a Stone with a man's fkull, teeth and "all, inclofed in it!"

From what has been faid, I prefume it may not be abfurd to infer, that every earth or clay, in fome places, may be converted to Stone in procefs of time, at fuch a depth where it is undifturbed, by being never lacerated nor molefted; and alfo where it abounds with an uncommon quantity of juices, of a lapidefcent quality: but this property being extenuated or deftroyed, the earthy Stones may, not improbably, again return to their primitive earth or clay. Thus we fee fome forts of Stone, when dug out of the ground, and expofed to the air for a confiderable time, do moulder again to earth, at leaft in appearance; while others, of an earthlike quality, are indurated, and become more compact and durable, by lying above ground. Hence fome have imagined, that all the terreftrial globe, and every individual inanimate thing contained in it, is nothing elfe but Water, rendered folid by petrifaction.

Thales, the Milefian, held Water to be the firft principle of all natural bodies, of which they confift, and into which they refolve. He endeavours to eftablifh this opinion, by arguments drawn from the origin and continuation of moft things: firft, becaufe the feminal and generating principle of all animals, is humid; and fecondly, becaufe all kinds of plants are fo much nourifhed by Water, that when they want moifture, they wither and decay. Some have not hefitated to father this philofophy on Mofes. The great prince of philofophers, Ariftotle, with Lucretius, Theophraftus, and Leonardus, were of the fame opinion. Nay, Hippocrates lays great ftrefs upon it; and of later days the great Sendivogius, with the moft learned of the Spagyrifts, who own that Water is an univerfal principle.

This Cryftalline or lapidifick juice, Mons. Geoffroy fays, is more heavy and fixed than fimple Water; and confequently is not evaporated with it, but is left behind: and thus the formation of Cryftal is perfectly like that of the Cryftals of falts. For thefe Cryftals only arife with thofe regular figures they affect, as when a Water impregnated with falts is flowly evaporated at perfect reft in a moift place. The evaporation of the Water is neceffary, that it may not keep the falts too far afunder; and the flownefs of the evaporation, that the falts may have time to take that arrangement, which agrees beft with their refpective figures. The application of this to Rock Cryftal, is obvious: it is only needful to conceive, that a Water charged with a quantity of Cryftalline juice, had infinuated itfelf through the clefts of fome Rock, where the aqueous part gradually evaporated.

An unfaline Cryftal earth, though not in fuch plenty as a faline, is yet as intimately mixed in Water, nay in the fulleft degree of clearnefs paffes through the clofeft ftrainers; confequently, the cryftallization of falt is here not improperly alleged for a model or pattern. (Henckell.)

It muft be confidered, that this Cryftalline juice is not equally diffufed in all parts of the Mine; fo that Rock Cryftal would not arife in all places, even fetting afide the neceffity of other concurrent circumftances, which do not often meet. If the Water impregnated with Cryftalline juice happens to penetrate a mafs of earth, which is the moft ufual cafe, it will connect and bind together the parts thereof by means of this juice; and afterwards, in proportion as the watery part evaporates, the compound will grow harder, and at laft become Stone. Add to this, that it will approach nearer to the nature of Cryftal, that is, it will be more hard and tranfparent, according as the quantity of that juice is greater; and at the fame time have a finer grain, according as the molecules of the earth are fmaller and more homogeneous. Of this kind are Marbles and Alabafters; in fome of which, one may difcern threads or veins, as tranfparent as if they were wholly Cryftal. The Stones moft oppofite hereto, and moft imperfect, are Chalk and Boles, which are little elfe befides earth ill bound together, with a very fmall proportion of Cryftalline juice, which leaves them ftill friable. Between thefe, it is eafy to imagine, there are infinite degrees.

Camillus Leonardus fays, that "Stones which abound moft "with the terrene, are thick and dark; neither are they free "from Water." And Ariftotle, in his book of Minerals, expreffly fays, "Pure earth doth not become a Stone, becaufe "it makes no continuation, but a brittlenefs; the prevalent "drinefs in it, permits it not to conglutinate; and fo by the "aqueous mixed with the terrene, Stones are made." By the aqueous, he means an unctuous or vifcous humidity, proportioned with a terrene; and according to the difpofition or proportion of of ſuch humidity with the dry terrene, divers and various Stones are produced.

The particular circumſtances which attend the formation of Stones, vary the effect of theſe general principles divers ways. For inſtance, if a portion of this juice, diluted in Water, happens to be ſurrounded with earth, and the juice be not in quantity ſufficient to petrify the whole earth as faſt as the Water evaporates; there will ariſe a maſs partly cryſtalline and tranſparent, and partly opaque, diſſimilar, and earthy: and ſuch we preſume is the difference of the Caples of our Lodes, and the contiguous ſtrata; the former being ſometimes more compact and firm by its contiguity to the juice percolating the vein, and the latter leſs ſo, by its proportional diſtance from the Lode If the ſame Cryſtalline juice be in the middle of the maſs, only the middle will have a Cryſtalline appearance and firmneſs; ſuch as the huge rocks of Cryſtal (Quartz) we often ſee riſe out of a vein or lode, which commonly implies a failure of Metal in that part of a Mine.

This Cement may be divided into three degrees of purity: the firſt a coarſe Quartz, which is the moſt impure, and covets no particular form; the ſecond is Cryſtal, which forms hexagonal columns, cuſpides, and pyramids, and is the connecting baſis of Slate, Killas, Granite, or Moorſtone, &c. But if by a ſtill greater degree of purity, the Stone becomes ſpecifically heavier, of better luſtre, and reſiſts fire almoſt to immutability, then it is called a Diamond; and the Ruby, Sapphire, Amethyſt, &c. are but this Diamond tinged and reduced, as to luſtre and hardneſs, by ſome metalline tint.

What is vulgarly called Spar with us, and which is ſo plentifully ſcattered upon the ſurface of every heathy common, is not the real Spar; and is, by moſt Lithologiſts, better known by the German name of Quartz, for want of a proper Engliſh appellative. Spar, by itſelf clear and unmixed, is very rarely found in this county. Indeed, the reaſon of its ſcarcity is, becauſe we have little or no calcarious ſtrata to produce it. The late Sir John Hill, in his hiſtory of Spar, which he divides into eighty-nine ſpecies, ſays, that Limeſtone is only coloured hardened Chalk, and Marble is the ſame. Marble is a purer Limeſtone, and Limeſtone a courſer Marble. Water being ſaturated with the principles of Sulphur, and with Chalk, keeps on its gradual courſe horizontally through the lime rock, till it meets a fiſſure, a perpendicular crack or opening, dividing one part of the rock from another. Here it ouzes forth; and meeting with a lighter air, ſuſpends and evaporates ſlowly.

We have ſaid before, that ſlow evaporation, and perfect reſt, are the requiſites of Cryſtallization. The Sulphur and pure Chalk thus united, form one ſolid body; which cryſtallizing gradually, ſometimes appear in regular rhomboidal particles; and is the ſubſtance properly called Spar. That the Spar formed in the fiſſures of rocks, is thus waſhed out of Limeſtone itſelf, is certain; becauſe none but Limeſtone rocks have Spar in their fiſſures. Rocks of a Cryſtalline matter, or formed of a vitrifiable Stone, have always Cryſtal, but never Spar, in their cracks or fiſſures. It grows continually; for whereſoever there is a crack in a Limeſtone rock, new or old, Spar always fills, and overruns the ſurface. Therefore the calcarious nature of Spar, is of its eſſence; and no form, nor all the other characters in the world, could conſtitute any production a Spar, that wanted this. It always ferments with acids, and burns to lime.

The formation of Spar is yet a ſubject of enquiry. Its atoms are all Spar; each particle, into which we can without violence divide it, is the ſame in all reſpects as the whole: and as the Foſſil world admits of no generation by egg or ſeed, it ſeems moſt probable, that all the variety of forms, in which we behold this Protean Mineral, are owing to no cauſe but the arrangement of rhombs, into as many forms as they are capable of producing. It fills the cracks of its own rocks, and of no other; for Cryſtal columns riſe from Cryſtalline rocks; and from Metalline maſſes fractured grows Mundick; each ſeparated from the great mixed body we ſee ſplit, and each formed into figures by its own laws.

The obvious ſcarcity of Spar in this county, is abſolutely proved in the almoſt total abſence of Limeſtone, whence it is mineralized; neither have we yet ſeen a perfect Sparry Rhomb in Cornwall.

It may be difficult to perſuade the vulgar Corniſh, that we have little or no Spar in our Mines; but that ſo it is, every unprejudiced obſerver may be convinced by the teſtimony of his own ſenſes. They denominate every ſpecies of Quartz and Cryſtal indiſcriminately, except the Pſeudo-Adamantes, Spar; ſo that in their opinion almoſt all the ſtreets in the county are

paved

paved with Spar inftead of Quartz; and with them every Cryftalline rock under-ground bears the fame name. It is time, however, that this confufion and mifnomer of Foffils fhould be abolifhed, and fuch miftakes and falfe diftinctions laid afide for the fake of order and propriety. Be it, therefore, henceforth remembered, that all thofe maffes of white and yellowifh Stones fcattered upon the furface of our lanes and commons, which are only ufed for paving and hedging, are Quartz, and have no Spar in them. If they were truly of a Sparry texture, they would fave us much expence and labour for Limeftone, which is now imported from Wales and Devonfhire; befides the cheap and ready manure they would afford, for the cultivation of our land.

Plain Cryftal hardens into any figure, of which its own gravity, and the matter in which it forms, will admit; and we find it veined in all our Killas, Caple, and every part of our ftrata, that is generally and vulgarly denominated the Country by our Tinners; yet it is perfect Cryftal, breaks irregularly, yields fire plentifully, is very hard to the graver, and will not ferment with Aqua Fortis. It will fometimes form itfelf in hexagonal opaque columns, cufpides, and pyramids, of an uncommon large fize, but of no value.

But if thofe pyramids are of a fine pellucid Water, they become the Pfeudo-Adamantes of the purer kind, and are thence eminently called Cornifh Diamonds; and are by Dr. Grew, and others, reckoned fuperior to the Briftol Stone, and every other diaphanous Cryftallization in Great-Britain.

CHAP. III.

Of Metals and Minerals, and the Fluxes for affaying them.

THE inferior Metals, efpecially Copper and Iron, are the eafieft of any to be diffolved by moft acid menftrua, their parts being very different, unequal, and heterogeneous in themfelves, and more fufceptible of any outward force or impreffion. We take this to be the caufe, why thefe two Metals are more fubject than others to be corroded and injured by expofure to the air, which abounds with volatile acid falts, and thereby becomes a menftruum, that readily adheres to, refolves, and corrupts thofe tender imperfect Metals; whereas Gold and Silver, whofe parts are moft folid, denfe, and homogeneous, receive little or no damage by contact of the acid falts. Lead and Tin likewife, not being eafily refolvable by Aqua Fortis or any water of that kind, are not near fo foon prejudiced by the faline pungent particles of air, as Copper and Iron are; which probably happens, becaufe they have a greater degree of fimilarity of parts better united; or becaufe they contain fomewhat that approaches to the nature of Sulphur, whofe property it is to refift all acid menftrua.

The word Ore, as alfo the word Mineral, in the largeft acceptation, comprehends any impure Concrete or Foffil, that contains either a Metal, Semi-metal, or Mineral juice; but if the fpecies of the thing fignified, be added to the word, then the particular fenfe or meaning of the expreffion is limited and denoted. Thus it is ufual to fay Copper Ore, Lead Ore, &c. The Ore of Antimony, The Minerals of Copper, of Lead, and the like; fo that the words Ore, and Mineral, are only fynonymous terms, that imply any kind of Mineral Foffil without expreffing its nature. Neverthelefs, a barren Mineral Foffil, which yields no produce in the fire, cannot well be termed an Ore, though it is called a Mineral; for it is improper to fay, the Ore of Mundick, &c. Cuftom however prevails fo much in the terms of our Miners, that they often call fuch Minerals as they know are of no value, by the name of Ores; and, therefore, to be more clearly underftood in what follows, by the word Ore, I mean only a Foffil or Concrete, which produces real Metal, as Gold, Silver, Copper, Tin, Lead, Iron, and alfo Quickfilver; by the word Mineral, I confine myfelf to the more crude Foffils or Concretes, which yield Sulphur, Vitriol, and other fuch brittle bodies; and by the word Semi-metal, I mean Antimony, Bifmuth, and Cobalt. I prefume it neceffary to make this diftinction, to prevent the perplexity in which thofe who are but little acquainted with the fcience of Metals, are often involved.

All things in the bowels of the earth, which occur to the confideration of a Mineralift, are reducible to the following claffes: firft, Earths and Stones; fecondly, Concrete Infpiffated Juices or Bitumens, as alfo thofe which are liquid; thirdly, Semi-metals; and fourthly, Metals. We fhall fpeak of each of thefe in their proper order.

First

First, of Earths; of which there are many forts of different colours and natures, whether fimple, or compound; and are to be efteemed among Ores or Metals, no further than with regard to the plenty or fcarcity of Metals or Minerals they feem to indicate; or elfe as indications which may be the beft method to extract the Metal that is intermixed with them: but I fhall not here profecute the inquiry into this fubject, becaufe I fhall have occafion to take particular notice of it hereafter.

We fhall likewife fay nothing of many remarkable Earths and Boles, as they have little or no connexion with Mines or Metals; fuch as Bole Armoniack, Terra Lemnia, Fuller's Earth, Lac Lunæ, Spanifh Bole and Terra Sigillata, except the Steatites or Soap Stone, which is in fuch plenty, and fo diverfified and beautiful, at the Lizard Point, as to have invited many Foffilifts to infpect its fituation, colours, quantity, and properties. The varieties of this Foffil, at the Lizard only, are divided by Dr. Borlafe into ten, whofe No. 1 which is the Steatites quæ paratonium antiquorum, No. 13 of Da Cofta, and the argella albiffima ponderofa tenax p. 17 of Hill, is found in veins about two fingers breadth at Gew-Grez cove, where it is carefully felected from the other forts, barrelled up, and almoft wholly engroffed by people employed under the managers of the Porcelain Manufactories. But the No. 14 of Da Cofta, which he defcribes as taken by himfelf from our foap rock, he eminently denominates Steatites vera; which I think he ought to have ftiled the Steatites Cornubiæ, as he recommends it to the China manufactories lately eftablifhed in this kingdom, and doubts not but we fhall be able to furpafs the manufactories of all other European nations, fince none have thofe Steatitiæ in fuch plenty and fo fine. It is remarkable, that letters written with Soap-ftone upon glafs, though infenfibly fixed, are not to be moved by wafhing, but always appear upon being moiftened by the breath.

The curious memoir in the tranfactions of the Royal Academy of Sciences at Paris, for 1727, communicated by the learned and indefatigable Monfieur de Reaumur, fully informs us of the art of making Porcelain, and the true fubftances ufed for that purpofe by the Chinefe: he has in that memoir judicioufly confidered China as a Semi-vitrification, and on the principles of burning the ware to that exact ftate, he has eftablifhed the perfection of the art. Now as all Earths vitrify, it is evident no true Porcelain can be made only of Clays, but other neceffary fubftances are required to hinder their perfect vitrification; and for fuch fubftances they can have recourfe to the Talky clafs, the Foffils of which almoft evade the force of fire, and on that account furnifh us with the fineft and beft ingredients. On this principle it is evident, that no fpecies of clay whatever, can be finer or fitter for the making up of China than thefe hardened Talky Soap Clays, wherein nature has blended the neceffary Foffils, Talk and Clay, ready for our ufe. Even a very fine common white Clay, properly tempered and mixed in fuitable proportions with our moift Talky Granite, or Moorftone, impalpably triturated, may furnifh us with the propereft materials to be had for a China manufactory. It remains, however, ftill to be obferved, that the Clay for China muft be very fine, extremely white, and cleared from every heterogene foil; for which reafon, in St. Stephen's and Breage parifhes, they pafs it through many lotions with clear water, before it is put into cafks to be fent off. Where we have feen a natural or adventitious mixture of Clay and Granite, with us, commonly known by the name of Grouan Clay, it has always anfwered for bricks to build fire places and furnaces with, equal to Stourbridge and other Clays; infomuch that plenty of it has been fent to Briftol, and the Welch Copper-works, for the purpofes before mentioned; befides that famous yellow Clay in the parifh of Lannant, which has produced fuch an handfome income every year to Humphry Mackworth Praed, Efq;. The manufactory, which was fet up within thefe few years at Truro, for the making of crucibles, is a very notorious proof of the ftrength of our Clays, when mixed with Granite, to refift the moft intenfe fire: no other crucibles are now ufed by our affayers; and the inventor has received the appointed premium for the difcovery, from The Society for the encouragement of Arts, Manufactures, and Commerce. Thefe crucibles have not one leaky neft among fifty; and the foreign pots, which were ufed till lately, had fcarcely fifty found crucibles among a hundred; fo that if the proprietor knows how to advance his intereft, he may export great quantities every year for foreign ufe, and fave a confiderable fum to this kingdom, which formerly went out of it for this neceffary article in metallurgy.

Stones are either common, or precious. There are alfo feveral forts of Stones peculiar to Metals, which are frequently met with in Mines, that, by their colours and confiftence, often denote either a profitable or barren Mine; fuch as Spar Stones, Quartz, and Fluors refembling Cryftal, by the Germans termed

termed Fluſſe, from their propenſity to melt in the fire, which are no bad ſymptoms of Metals, except thoſe Stones be hard, opaque, and untractable. There are ſeveral other kinds of Stones worthy of notice, which we omit here, and refer to their proper places, when we ſhall ſpeak of the different kinds of Lodes with reſpect to the Earth and Stones they contain. Of precious Stones, there are great diverſities of kinds, colours, and value ; yet there are few met with by Mining in Europe, of any great intrinſick worth : the knowledge of precious Stones, however, is not properly the buſineſs of a Miner.

Secondly, by Inſpiſſated Juices, and Mineral Waters, we mean all Mineral Suſtances, dug, or flowing out of the earth, either in a coagulated or liquid form. Of the latter ſort we ſhall not ſpeak further at preſent, but ſhall divide thoſe of the firſt kind into three ſorts, viz. Saline, Sulphureous, and Acid. Of the firſt are Sal Gem, or Sal Foſſile, Nitre, and the like ; of the ſecond, are moſt kinds of Bitumens, as Naptha, Aſphaltos or Pix Judaica, Petroleum, Sulphur, Pit-coal, &c. Laſtly, the acid ſorts are Vitriol, or Copperas, of which there are great varieties, produced either by nature or art. Native Vitriol is made in the bowels of the earth of an aqueous liquor impregnated with an acid ſalt, and of a cupreous or martial Mineral, ſtrictly united, both to a combuſtible ſulphureous ſubſtance, and to another body of a more fixed terreſtrial nature. (Boyle). The common green Vitriol or Copperas of the ſhops, is an artificial production ; great quantities of which, are manufactured by my friend Ephraim Reinhold Seehl, Chymiſt, at Blackwall and Deptford.

Dr. Rouby, a curious foreigner, ſet on foot a manufactory of Roman or Blue Vitriol, at Treleigh in Redruth, about five and twenty years ſince ; which dropped, only with a loſs of ninety pounds, by means of ſome diſputes and diſagreements among the perſons concerned. It was collected from the waters which were left from the lotions of Black Tin, after it had been calcined in the burning-houſe, for the diſcharge of its Mundick. This water, being ſtrongly impregnated with vitriolick particles, after it had been decanted clear from its dregs, was kept conſtantly boiling, by a gentle fire, for ſeven or eight days, in a leaden boiler ; when being evaporated to a pellicle, it was drawn off, and ſet to cryſtallize in proper veſſels. The time for cryſtallization, was generally three or five days, according to the different degrees of impregnation of the water ; eight tons of which, well ſaturated with vitriolick particles, would yield a ton of very fine blue Vitriol, far ſuperior to the Hungarian, or any other I have yet ſeen; at that time, worth about eighty pounds, and the expence of making about fifty. The materials are ſo plenty with us, that we could undertake to ſupply the whole world with this merchandiſe from Cornwall, by a cheaper proceſs than the foregoing. But the domeſtick demand for this ſalt, does not exceed twelve or fourteen tons ℘ annum; and our remote diſtance from the centre of the kingdom, will occaſion ſo great a charge in commiſſion, freight, carriage, &c. that it will hardly be worth the trouble and expence of apparatus and making. Beſides, without a patent for the ſole making and vending thereof, it would ſoon be in the hands of too many perſons, for the continuance and proſperity of the undertaking. Add to this, that they now make it at Birmingham of what they call pickle, and render it at nearly half the price they formerly ſold it for: and we imagine, that the continent may be ſupplied from the Cyprus and Hungarian Mines with an inferior Vitriol, of courſe cheaper, and what may anſwer their purpoſe almoſt as well.

There are alſo other ſorts of Copperas, which are diſtinguiſhed by their different colours, as Chalcitis, Melentaria, &c. which are only different degrees of the ſame recrementitious Mineral, and are now very little regarded. Other acid Foſſils, are native or rock Alum, or common Alum, which is made by art; but the Alom de Pluma, Alumen Plumoſum, ſeems rather to be the Amianthus, Aſbeſtos, or Earth Flax, whoſe fibres endure the fire and will not burn. The laſt, however, is rather a Stone than a Mineral; and has been found in the pariſhes of Landawednack and St. Clare in Cornwall very fine and perfect. Dr. Grew in his Muſeum of the Royal Society, ſays, "There is a "kind of Aſbeſtos, which grows in veins in a Clay and Mun-"dick Lode, between beds of a greeniſh earth, in our Corniſh "Mines;" but we never yet ſaw any thing of the kind in them.

The ſublimate of our white Mundick, if carefully ſwept from the funnels of our burning-houſes, and well ſeparated from the bituminous ſoot and ſmoke mixed with it, may produce, by confined fuſion, ſome of the beſt white Arſenick; and the more yellow Mundick may give a fine delicate ſtraw coloured ſort. If it is not ſufficient of itſelf, an addition of one tenth Sulphur, will perfectly do it; and by a further addition of Sulphur, a very

very fine red Arſenick may be obtained. But, if I am rightly informed, the moſt profitable torture this Mineral can undergo, is the ruducing of it into a beautiful Ultramarine, which is more valuable than Gold itſelf.

The Society for the Encouragement of Arts, has repeatedly offered premiums for the beſt compoſition to pay over ſhips bottoms, in order to defend them againſt marine worms, which abound ſo much in ſome parts of the Eaſt and Weſt-Indian ſeas, that veſſels new off the ſtocks, have been frightfully bored in their firſt voyage. Our county being altogether maritime, and the Mines being ſituated in the moſt narrow part of it, between the two channels, many of our adroit Tinners are equally converſant with naval and ſubterranean affairs. So true is this, that in St. Ives and Lelant, during the fiſhing ſeaſon, they are wholly employed upon the water, to the great hinderance of the adjacent Mines; and when the fiſhing craft is laid up againſt the next ſeaſon, the fiſhermen again become Tinners, and dive for employment into the depths of the earth. We have more than one inſtance, of a common labouring Tinner, after he has many years worked under-ground, becoming ſo complete a ſailor, as to be entruſted with the command of a large veſſel to the Baltick, the Levant, or any other part of the globe. This may ſeem ſtrange to ſome of our readers; but if it were much to our preſent purpoſe, we could make it appear, that there is in ſome parts of the two employments a great analogy, notwithſtanding the elemental difference. It is a maxim among us, that a good Tinner makes a handy Sailor.

It is not, therefore, to be wondered at, that many of our Tinners and Sailors have reciprocally attended to the object of the above-mentioned premium: the poiſonous qualities of our Mundick have engroſſed their attention accordingly; and they have complied with every direction in regard to the payment of timber with this poiſon, but all to no purpoſe. We have tried it in a preparation of our own, ſubtilized in ſuch manner, as to be free from thoſe cracks after it is laid on, to which the Mineral, by its ſpecifick gravity, when mixed with pitch and tar, is ſubject. It will be needleſs to deſcribe how we have tried it upon ſome of his Majeſty's packet boats at Falmouth, as the experiments did but partially ſucceed to our wiſh: ſuffice it to ſay, that no payment, however deleterious to animal life, will anſwer our expectations, unleſs it can be laid on in ſuch manner, and of ſuch conſiſtence, as to be equally ſmooth and free

free from the leaſt crack or ſeparation; and be of ſuch impenetrable hardneſs when dry, as to equal Metal, which alone is proof againſt the piercing auger of the Teredo: even petrified wood may be bored by the jaws of this worm, which we are told will penetrate Stone itſelf. Mons. de la Voye ſpeaks of an ancient wall in the Benedictines abbey at Caen in Normandy, ſo eaten with worms, that a man may run his hand into moſt of the cavities. (Philo. Trans.) Hence we will take upon us to ſay, that no payment whatever, even the moſt poiſonous, will effect the reſiſtance required; for the worm firſt of all introduces its auger, which is a callous, ſhell-like, inſenſible inſtrument, through the matter which is laid upon the wood, and continues working, till it has made a deep impreſſion into the ſubſtance of the timber, when it takes a turn, and works along with the grain of the wood, which it then feeds upon, and not before: whereby we ſee, it has eſcaped beyond the deſigned cauſe of its deſtruction, before the vital or animal part of it comes into action; ſo that we may be aſſured, that no payment will ſecure our ſhips bottoms, but impenetrability itſelf.

A quantity of the preparation here ſpoken of, was ſent ſome time ago to an eminent ſhip-builder at Rotherhithe, who returned for anſwer, "That he was very well ſatisfied, the com-"poſition would fulfil the moſt ſanguine expectations; but, he "thought it not the proper buſineſs of a ſhipwright, to advance "or encourage any ſuch undertaking, however laudable in the "eye of the publick; and he ſuppoſed every other artificer in "his way, would be of the ſame mind:" and in conſequence of this reaſoning, a few hundreds weight of the preparation were thrown into the Thames. We likewiſe recommended a trial of it to another ſhip-builder in this county, who ingenuouſly ſaid, "That he would firſt wait ſome trials of his own upon Mun-"dick very finely pulverized:" but he would not regard, or did not underſtand, my reaſons againſt the bare poſſibility of his ſucceſs.

The effect, however, that cannot be obtained by external application in the payment of a ſhip's bottom, may be produced by previouſly ſaturating the planks of which the bottom is formed. The planks that are laid upon the bottom or ſide of a ſhip, are firſt ſeaſoned in hot water, in order that they may be flexible, and yield to the form and ſhape of the mould, upon which they are laid. It is, therefore, only neceſſary to infuſe and mix with the boiling medium, a quantity of the above-

mentioned

mentioned compofition, which is one of the moft active, impalpable, and fubtil mineral minimæ, fpecifically to be obtained; and will infinuate itfelf and enter into the pores and vafcular conftitution of the timber, which being thus wholly faturated will have all the power and aculeated exertion of the moft effective poifon; fo that if the Teredo penetrates through the outward part of the wood, whenever he turns to feed upon the grain of it, he will be immediately deftroyed. This digreffion will, we truft, be excufed by many of our readers, on account of the importance of the fubject to commerce and navigation.

We fhall now go on to obferve, that thofe rapacious poifonous Minerals are often intermixed with Ores and Metals in the earth, though not fo often diftinguifhable; and from thence in a great meafure proceed that afperity and volatility which often happen to Ores in the fire, and which an unfkilful refiner is not capable of underftanding and correcting. We fhall, therefore, in few words, endeavour to give an account of thofe fluxes, which are moftly ufeful in the fmall examen of Metals by fire; in which bufinefs the affayer or artificer ought duly to know and confider the different properties of acids, alkalies, and neutral falts; and how they act with each other and agree with Metals.

Sal Nitre, or Salt Petre, is a native Salt; and is almoft peculiarly the product of the Eaft-Indies, from whence our Eaft-India company import amazing quantities. They have in a great meafure monopolized this article; and its vaft confumption in the manufactory of gunpowder, &c. muft render it a very important branch of their trade. It is alfo factitious, and may be made at home from the offals of flaughter-houfes, ftables, &c. It is a neutral hermaphroditical Salt, being neither a true acid nor alkali, though it is eafily convertible to either: it feems partly acid and very volatile, yet partly fixed, and is a great purifier of coarfe Metals, and will alfo deftroy and devour them, if not warily and judicioufly handled: it is intended further to liquify the fluxes with which Gold, Silver, and Copper are reduced and purged in the affay or crucible; which it does when expofed to the action of fire, in a pure and dry ftate, and foon flows with thofe bodies like water; whence it comes to be ufed in Metallurgy as a flux for thofe Metals.

Tartar, Argol, is a hard brittle faline fubftance, with which the fides of wine cafks are incrufted; and is red or white, according to the colour of the wine that produces it. An ingenious author ſays, " It has Bacchus for its father, fermentation for " its mother, and the caſk for its matrix." It conſiſts of a peculiar fixed ſharp Salt, not improbably inclining to urinous or lixivial Salts. This Salt in Tartar is exceedingly uſeful in fluxing and depurating ſome Metals, eſpecially Copper. Tartar alſo contains a vegetable Sulphur, which is very powerful in reducing and embodying the burnt or vitrified calx of Copper; for which reaſon, it is juſtly eſteemed the principal ingredient in the aſſaying that Metal. It is very good likewiſe, as well as Nitre, for purifying coarſe Silver, and for making Silver tough and malleable.

The moſt imperfect Metals, and the Semi-metals, melt more eaſily by adding ſalts to them, than they do of themſelves. However, they always loſe a great deal of their ſubſtance by this means, which happens eſpecially with regard to Copper, whereby an advantage to the buyers of Copper Ore, who ſmelt in their large furnaces without thoſe devouring and deſtructive fluxes, muſt neceſſarily ariſe. For if I buy five hundred tons of Copper Ore by a ſample of one ounce, which I have tried with ſome very ſmall loſs of Metal by the abſorption or rapacity of my ſaline flux; ſurely, the amount of Metal which will be ſaved upon ſo large a quantity of Ore being ſmelted without ſuch loſs, muſt be very conſiderable. Certain it is, that no loſs can happen to the buyer who purchaſes by the produce of his ſample; for it is impoſſible for the ſample to yield more Metal than it contains; and the waſte upon ſmelting a large body of Ore, is comparatively ſmall, cæteris paribus, to that of the ſample.

But, in order to prevent this loſs of Metal in ſome degree, you may add ſome kind of fat body, that will ſave it from deſtruction, and reduce the Metal. The flux proper for this operation is very well prepared by Cramer; and from its colour is there called Fluxus Niger, or Black Flux: but we intend to give it as our beſt reducing flux, according to our own method of preparation, in our chapter upon aſſaying. Tartar, being burnt alone, in veſſels cloſely ſhut, or detonated with Nitre, is moſt quickly alkalized, and thus retains a conſiderable part of the Oil, which it contains abundantly, and is fixed enough: for this reaſon, it very eaſily turns into a reducing flux. This flux, therefore, on account of its alkaline ſalts, diſſolves Earths and Stones, and changes them into an imperfect glaſs, by a moderate melting fire. But the Oil being of a more fixed nature,

nature, ftill remains concealed therein, and is requifite both to preferve Metals from being deftroyed, and to reduce fuch as are already deftroyed.

Different combinations of the above falts are ufed by different affay-mafters with us, for trying of Copper Ores; but the Black Flux, or the White Flux, (which fhall be given hereafter, and which fome call their Refining Flux) with careful management, and proper attention to the crucible during the procefs, will equally anfwer the purpofe notwithftanding the appearance of myftery which our affayers affume.

Rock Salt, or Sal Gem, Sal Foffile, and Common Salt, are all of a mild nature, though they become acid menftrua by diftillation. Common Salt is of great utility in the refining of Copper in the affay, becaufe it fwims on the matter in fufion; in pouring out of which, the Salt firft flows out, and greafes the lips of the crucible, if we may ufe the expreffion, infomuch, that the Metal may be poured forth, without fticking to the fides of the veffel. It is likewife ufeful to prevent the deflagration of the Metal in fufion, which otherwife may be burnt and deftroyed; therefore it is always at hand with our affayers to fprinkle into the crucible, when a flame iffues from the liquified contents, which it immediately damps and puts out.

Borax, Chryfocolla, Gold Solder, may be termed the Gum of Metals, from its ufefulnefs in foldering them. It is a neutral falt, almoft infipid to the tafte, of a very mild nature, and not corrofive; and though it flows not exceedingly liquid in the fire, yet it makes Metals eafily fufible. Its chief intention in affaying, is to fuftain and fufpend the recrements of Metals in their impure fcoriæ; or to throw fuch drofs upon the furface in a vitrified form; whereby they are purified from their heterogeneous matter. Borax is an artificial depuration from a certain mineral juice called Tincal by the Arabians; and fome German authors, fay, "That a native Chryfocolla or Borax, is dug out "of Copper Mines;" but we never knew of its being found with us.

Sandiver, Scoria Vitri, is the fæces and dregs of glafs. It is an Alkali, yet feems not void of Sulphur; for an ebullition enfues when it is melted with Nitre, and it is ufed, though feldom, in affaying of Copper; but it is excellent to collect burnt Silver, and Silver filings, to a body; yet it always makes the

the Silver foul and brittle, which therefore is further cleanfed by melting with the proper reducing flux.

Alga Marina, Kelp, Kali, Fucus, or burnt Ore-weed, contains much falt, of an alkaline quality; as do all forts of burnt weeds, and Flemifh pot-afhes much more, being better prepared. Kelp is the ftaple commodity of the Scilly-Iflands, where great quantities are made in the months of June and July. All thofe kinds of lixivial falts, are not very corrofive, and are proper in fome cafes for proving of Copper Ore.

Sal Ammoniack, Sal Arenarius. In former ages, a genuine native Sal Ammoniack was brought from a certain place near the temple of Jupiter Ammon, whence it took its name; and was faid to proceed from the urine of camels fed only on green vegetables: but the falt we now have, is factitious from the foot of camels dung burnt; after which it is fublimed into cakes. It is exceffively volatile, and is chiefly ufed in making Aqua Regia, which its diftilled volatile fpirit ferves to mortify, whence it becomes a precipitator of Gold. It is of ufe alfo in foldering; and in tinning of Copper and Iron veffels, by making the Tin adhere to them.

Common glafs is fometimes ufeful in trying of Copper Ore; for, in melting, it is of a thick ropy confiftence, and therefore ferves to entangle and fufpend the impurities of the Ore, fo that the Metal is better difengaged from its incumbrances and dregs, or purged and feparated from its defilements. For thefe reafons, feveral forts of Earths, Spars, and Fluors, with Iron Slags and Ores, may in fome cafes be ferviceable ingredients as fluxes for Copper Ore, by their ropy and abforbent qualities. We know an inftance immediately at hand, where the very Slag of Slags is re-melted with impure Copper Ore for thofe purpofes.

Charcoal, Carbo Ligneus, is endued with a vegetable Sulphur, and is therefore often of great confequence for reducing to a body the Ores of Tin, Copper, and Lead, being ufed as a flux and fuel both. Culm, fo called, is the popular flux for affaying of Tin after it is dreffed. Pit Coal is entirely improper for any reducing flux.

Thirdly. We come now to fpeak of Minerals and Metals more particularly; and fhall endeavour to diftinguifh moft of them,

them, as they are met with in this county, by their various names and ufes. We will here fub-divide Minerals, firft, into thofe of an impure fort or kind, and of no value for Metal; and, fecondly, into thofe which are of ufe, and yield fome produce in fufion, fuch as Antimony, Calamy, and other Semi-metals. By the firft fort of Minerals, we underftand all Cachymiæ, Marcafites, Pyrites, or Fire-ftones; which feveral names are well comprehended in the word Mundick, whofe great Emporium is Cornwall. We fhall here but lightly touch upon the natural hiftory of this Mineral Glebe, having already given our thoughts upon fome of its properties and ufeful applications. The figures of Pyrites being extremely various, the following are the principal: Pyrites Idiomorphos, which is fpherical, and hemifpherical; in this laft form, it is generally found radiated and lamellated, oval, cluftered, criftated: angular, confifting of four or fix fides; and this laft cubical, or teffellated, oblong, rhomboidal, cellular or honey-combed: fiftular or piped: all of which are common to Cornwall. (Henckell's Pyritologia.)

It may be generally divided into three fpecies, viz. Marcafita Argentea, Aurea, and Alba Ponderofior. It may be alfo claffed under numerous fpecies of Pyritæ, fuch as the Gymnophyris, Pyritrichum, Pyritrichiphyllum, Pyricubium, Pyripolygonium, Pyroctogonium: but as all thefe names will only ferve to confound the bulk of our readers with technical difficulties, it is fufficient to fay, that the forms and colours of this Mineral are innumerable.

We find it very plentiful in Lodes of Tin, Copper, and Lead; with which it is fo intimately mixed, that it commonly impoverifhes the value of each of its companions, notwithftanding every known method is ufed by fire, water, and various manuductions, to feparate and cleanfe them from it. Though it is fo generally diftributed in thofe Lodes, it does not incorporate with Copper Ore; but is disjunct, yet not entirely feparable. But from Tin, its union is fometimes infeparable by water; efpecially if the Tin is of a lax, fandy, pryany, or clayey texture. Its connection with Tin in the hard Stone, is often the fame, if the Stone is of a peachy nature, and where the moleculæ of both Minerals are equal. In either ftate it being fpecifically heavier, no lotions will ferve the purpofe for difunion, but the moft perfect uftion muft be complied with to evaporate part of it, and reduce its ponderofity within the power of future ablutions to carry off: when we come to defcribe the

 method

method of dreſſing Tin, we ſhall explain the proceſs for burning it. After all that can be done, Mundick is ſuch a mortifying inmate, as by its communication corrupts the goodneſs of the Metal, and renders it harſh, brittle, and ill coloured.

Many are the Lodes of pure ſolid Mundick, without any mixture of Tin, Copper, or Lead. It may in general be ſaid, that Pyritæ are to be met with in as many different forms and poſitions, as other Minerals are: ſuch as vein-wiſe, when the Ore ſtretches downwards, oftner ſloping a little, ſeldom quite perpendicular. Squat-wiſe, or in a horizontal poſition; that is, if not always quite level, yet hanging much, and dipping a little. (The ſame as a true Lode plot) (Henckell). But as theſe Lodes of Mundick are not found to produce our Metals, after ſome little trial they are not deeply enquired into, and are ſoon relinquiſhed. If they were patiently ſunk upon, they might poſſibly produce Tin or Copper in depth; and it is a general maxim among the Miners, "That a large Lode of "Mundick commonly rides a good horſe:" indeed, we know ſeveral inſtances of very large Mundick Lodes, anſwering the purſuit of the concerned with abundance of Copper Ore in depth: from whence many writers have maternaliſed this Mineral for Copper, which is baſtardiſing the daughter, whoſe real mother is Goſſan; and yet Mundick does partly contain the ſeed or vitriolick principle of Copper, and therefore it may with propriety be termed the father, and Goſſan the mother, or matrix, to fecundate the ſeed.

Mundick is continually forming concretions; and, perhaps, none of the Foſſil kingdom will ſupply us with more recent and viſible proofs of the like activity, in the ſame ſhort ſpace of time: we think, we have ſeen it make conſiderable advances, in three or four years. Poldyſe Mine has lately furniſhed the curious with many ſpecimens of Cryſtals of all ſizes and ſhapes; particularly of an hexagonal column, terminated with hexagonal pyramids at both ends, four, ſix, and eight inches long, to ſix in the circumference. Some of theſe Cryſtals are beautifully correct and clear; others have one or two planes tinged with a browniſh ochre, two or three of the planes, both columnar and pyramidal, are granulated with very minute glittering ſparkles of Mundick, variegated like the rainbow; the oppoſite ſides are coated half an inch thick, with high bliſtered incruſtations like grapes; others, are totally capped with Mundick at one pyramid, and quite clear at the other; many of them ſo beautiful

beautiful and ſplendid, as to exceed the Iris, or the peacock's tail.

In theſe incruſtations, we ſee the various degrees of approximation of matter ſui generis; and from thence muſt conclude, that thoſe Pyritæ are modern to the Cryſtals upon which they are formed, in direct oppoſition to thoſe Mineraliſts, who ſay, all Metals, Minerals, and Foſſils, were formed at the creation, as we now find them. "A circumſtance not the leaſt remark-"able, is, that Ores are found upon Sinter or Dropſtone, in "the ſides and roofs of old Mines; a proof of their temporary "exiſtence, and that they are not coeval with the world. In "ſhort, Mundick is a thing that has grown, ſtill grows at this "day, and will continue to grow on Druſe, (a honey-combed "Stone) ſo long as the interior parts of this maſs of earth are "ſubject to thoſe motions and diſſolutions they hitherto have "undergone." (Henckell's Pyritologia). Neverthelefs we have met with one of theſe Coevaliſts, (otherwiſe a very ſenſible man) who inſiſted upon it, that thoſe Mundick concretions were immediately formed at the creation, upon the Cryſtal, while it was in a liqueſcent ſtate; and at the ſame time denſe enough to ſuſtain, and ſupport the ponderous Mineral, that it might not fall into, and deſtroy the geometrical configuration of the Cryſtal.

We have likewiſe many ſpecimens of Mundick, which are wholly coated over with Cryſtal: and a large opaque maſs of Cryſtal, ſhall contain a very rich piece of Copper Ore in the middle of it, almoſt totally impervious, till fractured by the ſledge. Again, there are large rocks of Copper Ore, ſometimes found, in all appearance as if they were ſolid; on breaking of which, a cavity is found in them, containing a looſe Pyricubium, or exquiſitely gloſſy cube of Mundick. All theſe are ſimiliar proofs of the doctrine, which we laid down in the firſt place. Another example whereof, we have in Ilva, an iſland adjoining unto Tuſcany, full of Iron Mines, which when they have dug as hollow and as deep as they can, the circumjacent earth falls in, and fills them up again; and in the ſpace of fifteen years at moſt, they work thoſe Mines again, and thence draw out abundance of Metal, which this new earth hath been converted into, and which can be attributed to nothing but to the perpetual accumulation of this and other Minerals, (Alonzo Barba).

Other

Other crude Minerals of no efteem, are thofe of a ferruginous quality, which the Miners diftinguifh by the names of Goffan, Cal, (more properly Gal) Cockle, &c. Our Goffan Lodes often produce Tin at a fhallow level in tolerable plenty; and chiefly that Goffan which is of the moft ferruginous ftamina, and we believe from thence denominated Gal, which is old Cornifh Britifh, and fignifies ruft; and being really an inferior Iron Ore, anfwers in name to its appearance. The Germans call it Wolffram, and define it a kind of Manganefe. In this kind of Goffan, after the Tin is feparated from all other impurities by repeated ablutions, there remains a quantity of this mineral fubftance, Gal; which being of equal gravity, cannot be feparated from the Tin Ore by water; therefore it impoverifhes the Metal, and reduces its value down to eight or nine parts of Metal for twenty of Mineral, which without this brood, fo called, might fetch twelve for twenty. Afterwards it is coveted by fome of the Smelters, to mix in their large furnaces, where it acts in conjunction with fome forts of Tin as a defirable flux; and increafes, though it may depreciate, the lump of Metal.

The general definition of Ochres in Cornwall, may be thus fpecified: the rufty Ochre of Iron called Goffan; the green and blue Ochres of Copper, Verdigreafe; the pale yellow Ochre of Lead, of a Goffan appearance, but like Calamy; the brown and blackifh yellow Ochre of Tin, called Goffan, Cal, Gal; and the red Ochre of Bifmuth. Thefe Goffans or Ochres, are commonly called the Feeders of their refpective Metals; and where they are found, the Metals are generally, and very juftly fuppofed to be not far off.

Cockle (the Skiorl of the Swedes, and the Schorl of the Germans; in Englifh, Shirl) is a brown or blackifh gloffy ftony matter, intermixed with Tin Ore in fpots and veins; often fhining and refembling the Cryftals of Tin Ore, from which by its weight, it cannot be well feparated; and in the Stone is not unfrequently miftaken for it, to the difappointment of the Tinner, when it comes to the teft of the fire. This Cockle compofes a part of the moft beautiful charge of our Granite or Moorftone; in which it is fo variegated with black and white Talck, that when the fun fhines upon it, the beholder is dazzled with its fplendour.

Talck, which is the Lapis Specularis, and has the feveral names of Gold and Silver Talck, Glimmer, Glift, Catfilver, and Black

Black Talck, is very plenty in Moorſtone as before; but of ſuch ſmall diameter as to be no way valuable, unleſs in the Stone, for its lucid appearance. There is another ſort of Talck common to our Tin veins, a bluiſh Iron Ore. If Talck gets among Tin, it is a very deceitful brood, as it imitates the colour of the Tin with which it is in conjunction; and when ſtamped, it preſerves its foliaceous laminated form, whereby the water in the buddle ſlips over its leafy ſubſtance; but if it had been more granulated or angular, the water might poſſibly have more force upon it, and ſeparate it from the Tin, on account of its peculiar levity. In this ſituation, it is known among the Tinners, by the name of Clift, Glift, or Glidder. However, Talck and Cockle, ſeem to be of the foliaceous ſtony kind, and are mentioned here only as troubleſome companions with the Ore of Tin.

Fourthly; Semi-metals. Hill ſays, "The Tin Mines of "Cornwall afford great quantities of Biſmuth, though it is "very little known there." This is a great miſtake; for Biſmuth is very well known here, and our Tin Mines never yet afforded any quantity worth the ſaving. That we have Lodes of Biſmuth, and thoſe of Cobalt and Biſmuth together, is very true; but hitherto of little worth. According to the opinion of foreigners, no place exceeds Cornwall for variety and plenty of Minerals. "Beecherus refert de Cornubia, in dedicatione "alphabeti ſui Mineralis, ſe credere nullum terrarum locum "reperiri, qui minerarum multitudine et varietate antecellat." This ſhews how great reaſon we have to lament our ignorance in the examen of other Minerals beſide thoſe which produce Metal. If thoſe of our county, who have leiſure and ability to look into the contents and properties of our various Foſſils, would employ their talents for that purpoſe, we ſhould not long remain in our preſent darkneſs; a little time would bring to our knowledge the value and uſefulneſs of much neglected treaſure. Even ignorant pretenders to docimaſtick operations, might in time blunder out ſome curious diſcoveries; and accident might effect, what prudence may not accompliſh. Unfortunately for us, none pry into the concealed contents of our numerous Foſſils; for the attention of the natives is principally engroſſed by Tin and Copper.

Biſmuth in the ſtate of Ore, is uſually of a bright ſilvery white, and of an obſcurely and irregularly foliaceous ſtructure. Sometimes it appears granulated; and at others, the granules are large, and the maſſes coarſe; in which caſe, every ſeparate granule appears of a cubick form. It is ſubject to fewer variations in its Ore, than moſt other Minerals; but is ſometimes turned yellow by an over proportion of Sulphur; and ſometimes is very deeply tinged with the matter of common Mundick, and is often miſtaken for it. (Kunkel, Boerhaave).

It is eaſily ſeparable from its Ore, and may be made pure by merely melting the Ore alone in a crucible in a moderate fire: when it is in a more impure ſtate, it is procured by an addition of the reducing flux before mentioned; but if the fire be too fierce, the Biſmuth will be loſt.

A ſmall portion of Biſmuth increaſes the brightneſs, hardneſs, and ſonorouſneſs of Tin. The uſes of Biſmuth are, for making Pewter with Tin; for ſoldering ſome Metals; for printers types; foils for mirrors; for anatomical injections; for imitating Silver on Wood; for purifying Gold and Silver by cupellation; and for rendering ſome Metals fitter for being caſt into moulds, as it increaſes their fuſibility.

Zinc; the Ore of which is Lapis Calaminaris. Great quantities of Tutenag were till lately imported from the Eaſt-Indies; but the late Dr. Iſaac Lawſon obſerving, that the flowers of Lapis Calaminaris were the ſame as thoſe of Zinc, and that its effects on Copper were alſo the ſame with that Semi-metal, never remitted his endeavours, till he found the method of ſeparating pure Zinc from that Ore. Cadmia, or Lapis Calaminaris, is a ſpungy ſubſtance, of a lax and cavernous texture, yet conſiderably heavy. It is found in maſſes of various and irregular figures, with rugged and uneven protuberant ſurfaces. When moſt pure and perfect, it is of a pale browniſh gray colour; but its lax and ſpungy textures, make it very liable to be fouled by extraneous matter, and thence it is often found yellow or reddiſh. It is moderately hard, but will not give fire with Steel; it will not effervefce with Aqua Fortis; and it calcines in a ſmall fire to a pale red. In fact, the Ochre of it is a Goſſan; and though the above deſcript is the true and genuine Mineral of Zinc, yet that Semi-metal is not confined to that Ore alone, but is mixed in great abundance in its diſſeminated particles among the matter of the Ores of other Metals, particularly of Lead.

Mock Lead, Black Jack, and Blende of the Germans, is really a contaminated Zinc Ore, (and ſome of it even very little

ſo)

ſo) and would anſwer every purpoſe of it, if it was not in general ſo united to the principles of Iron and Arſenick. It is the moſt plentiful Mineral we have next to Mundick, and has of itſelf diſtinct Lodes; but it is moſt commonly mixed with Mundick in ſome of our Copper Lodes, before they are wrought to any great depth. It has been much uſed for the making of Braſs, inſtead of Calamy: ſeveral ladings have been ſhipped off for that purpoſe, at the price of forty ſhillings down to a moidore ℔ ton; which might pay for the dreſſing of it, as the Burrows, or heaps of refuſe in ſome Copper Mine Bals, will ſupply great quantities of it.

To extract the Zinc, the Calamy muſt be finely pulverized, and well mixed with one eighth part of charcoal duſt, and put into a cloſe retort, to prevent the acceſs of air, which would inflame the Zinc as it riſes. The retort is to be placed on a violent fire, ſufficient to melt Copper. After ſome time, the Zinc riſes, and appears in the form of metallick drops within the neck of the retort, which, when cool, you break to take out the Zinc.

Lapis Calaminaris with Copper, makes Braſs; Zinc with Copper, makes Princes Metal, or Bath Metal; and improves Tin in whiteneſs and hardneſs, in the compoſition of ſome Pewter.

Stibium. Antimony. This Semi-metal in its Mineral Ore, is of a dark lead colour, ſtaining the hands black; and is generally full of long ſhining needle-like ſtriæ; though often of an exceeding ſmall cloſe grained texture, hard, brittle, and very heavy. It is found in different parts of Europe, as Bohemia, Saxony, Tranſilvania, France, and even in England in ſome conſiderable quantities, though as far as we yet know, confined to the counties of Cornwall, Devon, and Somerſet; from the north-weſt quarter of the latter, only a few ſpecimens; from different parts of Devon ſome tons; and formerly from Cornwall, in quantities of twenty, and even thirty tons. In the laſt three years this county has produced about one hundred and twenty tons from one Mine called Huel Boys, in the pariſh of Endelian; viz. in the year 1774, nineteen tons, at £. 13 ℔ ton; in 1775, forty tons, at £. 13 10; and, in 1776, thirty-ſix tons, at £. 14 14 ℔ ton. The expence of getting this Antimony, excluſive of driving an adit to the Mine, has been leſs than one third of the amount of its produce. The remainder

remainder of the one hundred and twenty tons above mentioned, is chiefly the product of a Mine near Saltaſh, belonging to Mr. Thomas Reed and partners.

The direction of the antimonial veins, is moſtly from north to ſouth ; but there are now and then ſome ſmall quantities found in veins which run different courſes, and which, from their ſuperior product of other Minerals, are denominated according as the different Metals predominate. Antimony lies in its veins or Lodes extremely unequal, but generally more ſo length-wiſe than in depth. It is not uncommon to have the vein two or three feet wide, and in driving as many, not only the Mineral, but even the vein itſelf will be ſcarce perceptible. We have not known any of this Mineral wrought more than fourteen fathoms deep. The Mine of Huel Boys above mentioned is about twelve fathoms, and in the bottom promiſes continuance.

Foreign Antimony does not come to us in the ſtate of its Ore, but what is, however, called Crude Antimony ; which is obtained from its earthy and more ſtubborn mineral particles, by a kind of eliquation, in the following manner. The Mineral is put into earthen pots pierced in their bottoms with ſmall holes ; theſe pots are placed in a furnace, where they receive the neceſſary heat for the fuſion of the Antimony ; but much leſs than is ſufficient to fuſe any other of its mixtures, except Lead, with which it is often combined, and which even this fuſion will be ſufficient to melt with it into the ſame maſs. For this reaſon, Crude Antimony uſed medicinally ſhould undergo an examination, to diſcover whether it has Lead in it ; as I am informed it may have a conſiderable quantity without altering its ſtriated texture, and for which reaſon I am inclined to believe, that Engliſh Antimony is the leaſt proper for medicinal uſe, as it is more liable than Foreign to a ſaturnine mixture. This Crude Antimony comes to us in the form of the pots or moulds in which it has been melted. Some of the Antimonial Ores of this county, without any ſuch preparatory fuſion, have been found to produce at leaſt as large a quantity of Regulus, and equally fine, as the beſt Foreign Crude ; and as they generally lie very rich in the earth, this fuſion is moſtly rendered unneceſſary.

Mr. Reed has erected furnaces in Feock pariſh, on Reſtronguet river, for extracting its Metal, commonly called Regulus of Antimony ; which is performed by mixing the clippings of the

the Tin-Plate Workers with the Mineral Ore, firſt well cleanſed from its ſtony earthy parts, and ſmelting this mixture in pots containing from a half hundred, to one hundred weight: in which operation the reguline part of the Antimony, freed from its Sulphur, by the latter's uniting with the Iron in the before-mentioned clippings, by its ſuperior gravity ſinks to the bottom of the pot, leaving the other parts in a light mineral-like ſcoria on the top, which readily ſeparates when cold. The foreign Ores of Antimony are melted in London, for theſe purpoſes, in the ſame manner; only Mr. Reed's is done in an air furnace, and in London they uſe the bellows as in other ſmall founderies. The uſe of the clippings is for the ſake of cheapneſs and convenience, for a ſomewhat leſs quantity of ſmall Iron alone will effect the precipitation. Regulus of Antimony may alſo be obtained by ſubſtituting, for the Iron, Copper, Lead, or Tin; but theſe muſt be added in a much greater quantity, and the operation conſequently will be attended with much more expence, and greater difficulty, and are, therefore, ſubſtituted only on very particular occaſions. The greateſt conſumptions of Antimony, beſides the medicinal, are made by mixing its Regulus with Tin to make Pewter hard and ſonorous; and with Lead, &c. for Printing Types; though it has ſeveral other uſes.

Cobalt, is a denſe compact and ponderous Mineral; very bright and ſhining, and much reſembling ſome of the Antimonial Ores. It is ſometimes found of a deep, duſky, bluiſh black; very heavy and hard, and of a granulated ſtructure, looking like a piece of pure Iron where freſh broken: at other times it is found more compact and heavy, and of a very even texture, not granulated or compoſed of any ſeparate Moleculæ, but reſembling a duſky maſs of melted Lead on the ſurface, and will bear to be cut with the knife. The inner part, where it is always very bright when freſh broken or cut, is alſo found, in ſome places, in a much more beautiful appearance than either of theſe, being of a fine bright ſilver gray, and of a beautiful ſtriated texture, the ſtriæ running all great lengths, but very ſlender and variouſly bent, undulated, and in ſome parts broken. It is alſo ſometimes ſoft, and covered with a bluſh coloured efflorefcence, which is generally rich in Regulus.

We have given our thoughts upon the ſubject of Arſenick, and ſuggeſted that it may be cheaply rendered by our Mundick ſublimations, after the manner in which it is procured from

O Cobalt;

Cobalt; and the more we look into, and conſider the operations whereby Arſenick, Zaffre, and Smalt, are obtained from this Mineral, the more we are convinced, that a ſkilful hand may improve upon the hint in relation to the different ſorts of our repudiated Mundick.

We have had but one Cobalt Mine that ever was diſtinguiſhed by that name in this vicinity, which was diſcovered accidentally by Mr. Beauchamp, in an adit that he drove through ſome part of his eſtate at Pengreep in Gwenap. He diſcovered a Lode of three feet breadth, which contained a branch of real Cobalt; and it happening about the time when the Society of Arts, &c. offered a premium of thirty guineas for the beſt Cobalt to be diſcovered in England, he was honoured with the reward for his ſpecimen, purſuant to the advertiſement. It did not hold in depth, but ſoon deſerted the purſuers; who were likewiſe very ſoon after obliged to ſuſpend their ſearch, by a prodigious influx of water to their workings.

At Huel Trugo alſo, a Copper Mine near St. Columb, ſome of the pureſt Cobalt has been worked. It was in a ſmall vein, four to ſix inches big, in which there were no other mixtures. It croſſed the Copper Lode, which was pretty large, though not rich; and the Cobalt lay in the vein juſt where it joined the other, but did not hold to any length, ſo as to make it worth purſuing. It was very fine, and ſuppoſed by ſome who think they know the value of it, to be worth more than ſixty pounds ℔ ton. It was of a pale red, or rather bloſſom colour; and, on being expoſed to the air for any conſiderable time, the ſurface was covered with a farinaceous ſubſtance reſembling the ſublimate of Arſenick, which it probably was; but leſt the fine colour ſhould evaporate, the proprietor, Mr. Champion, ordered it to be put into caſks filled up with water. The common air was, or ſeemed to be, the menſtruum, which diſſolved the ſurface of this Mineral, which it is probable in proceſs of time, as it became longer expoſed to it, would have totally crumbled into that floury ſubſtance. Cobalt is alſo ſuppoſed to be in no ſmall quantity in Dol-Côth Copper Mine, for the aſſayers generally find their pots tinged with blue; yet it ſeems to be ſo blended with Copper and Iron that it does not diſcover itſelf in a mineral ſtate, being probably but in the general term of Mundick. Very good Cobalt has alſo been diſcovered in Dudnan's Mine in Illogan pariſh; and in a Mine wrought for Tin and Gal near Pons-Nooth in Perran-Arwothall.

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In the laſt place, we come to define Metals only, which we ſhall preſume to be ſuch on the reſpective principles of their ductility and gravity. Their malleability may ariſe from the figure of their parts, perhaps oblong or ſquare, which may occaſion their cohering ſo ſtrongly, as not eaſily to be ſeparated; and it is probable, the pores of their conſtituent particles, or of the whole maſs, are few and ſmall; which may account for their being ſo much heavier than any other bodies. The radical characters of Metals ſtand thus: the weight of Gold to that of Glaſs, is as 9 to 1; and the weight of Tin, the lighteſt of all Metals, is to that of Gold, as 7 to 19: which conſiderably ſurpaſſes the weight of all Stones, and other the moſt ſolid bodies. The ſpecifick weight of the ſeveral Metals, and of Granate, Water, and Air, ſtands thus:

Gold	19,636	Copper	8,843
Platina	17,000	Iron	7,852
Quickſilver	14,019	Tin	7,321
Lead	11,345	Granate	3,978
Silver	10,535	Water	1,000
		Air	$\frac{3}{11}$

Formerly there were but ſix Metals ſo denominated, to which by ſome was added Quickſilver, which has every property of Metal except fixidity. To theſe we ſhall add another original Metal lately diſcovered in the Spaniſh Weſt-Indies, and by the Spaniards called Platina, from its reſemblance in colour to Silver, from which it would not be ſo well diſtinguiſhed, but by its ſuperiour gravity, and inferiour ductility; which particularities are extremely remarkable.

Gold, by the ancients, was characterized the ſun, which they imagined did influence and produce it. Gold is very rarely ſeen in a ſtate of Ore; being of all Metals moſt frequently found native. It is a general opinion, that it never was found in a mineral ſtate, but always pure and metallick: I have, however, ſeen, in the poſſeſſion of that curious inveſtigator of natural productions, Dr. Hunter, a large ſpecimen of mineralized Gold, which the doctor had from Germany: one point of it was pure Metal and Quartz; and the other, I confeſs, had all the appearance of a mineralized Gold Ore.

Gold is free from Sulphur and Arſenick; has no certain figure; and is found pure in Flint, white Quartz, or debaſed Cryſtal.

Cryſtal. It is ſeen in Lapis Lazuli, and ſome of our pebbly ſtream Tin. It is not uncommon to meet with Grains of ſolid Gold in our ſtream works; and ſome large pure lumps have been met with in thoſe works for Tin Ore, of which the late William Lemon, Eſq; grandfather of the preſent Sir William Lemon, Bart. had one that weighed fifteen penny-weights and ſixteen grains. That there were ſuch grains, called Corns of Gold, formerly obſerved in ſtream Tin, we have the authority of Mr. Carew, fol. 7; and in the Bayliff of Blackmoor, a M. S. in my poſſeſſion, written by one Mr. Beare in queen Elizabeth's time, there is an account of a gentleman, "who at a waſh of "Tin, at Caſtle-Park near Loſtwithiel, took up out of the "heap of Tin certain fine Corns, Hops, or Grains of Gold, "which they called Rux; and at the ſame time, ſhewed a "Gold ring on his finger, made of certain Gold, which he had "gathered out of the Tin at a waſh in a ſtream work, together "with another Gold ring, each of ſixteen ſhillings and eight "pence value." He likewiſe tells us of "two blocks of Tin, "carried by one Mr. Robert Davy to Bourdeaux, which were "by two Florentine merchants valued to be worth all the reſt "of the Tin there, by reaſon of the Gold contained in them." The late William Glynn, Eſq; grandfather of the preſent learned recorder of London, had a large Gold ſeal ring, made of Gold found in the river under his houſe at Glynnford. Whether the great Mr. Boyle had heard of theſe facts, or that it was a notion of his own, it is moſt certain, that he imagined a good quantity of Gold might be extracted out of Tin, without prejudicing the Metal; and to that purpoſe, ſent down Chriſtopher Kirby, Eſq; (well known for having been unhappily drawn in by Dr. Oates to countenance his plot) to make ſome experiments therein, in the latter part of the reign of king Charles the ſecond. But in a few months after king James came to the crown, Mr. Kirby being apprehenſive of ſome ill uſage on account of Oates, fled into Holland, from whence he returned with the prince of Orange; and Mr. Boyle's death happening much about the ſame time, this project fell to the ground.

Of all Metals, Gold is eaſieſt to be amalgamated with Quickſilver; ſo that a Gold ring being a little touched with it, will be no longer uſeful to the owner if the Quickſilver is not ſpeedily burnt off in a ſtrong fire. It is diſſolvable in Aqua Regia; but a true Aqua Fortis makes no impreſſion on it; for if you put into it a piece of gilt Silver wire, whoſe Silver is half a grain, and the Gold but one ninety-fixth of a grain, drawn into the length of an ell, the Silver will be eaten out, and a tube of Gold fhall remain, which, notwithftanding its extreme thinnefs, will be ftill opaque. The ductility of Gold is beyond all imagination. By exact weighing and computation it has been found, that there are Gold leaves, which, in fome parts of them, are fcarce the three hundred and fixty thoufandth part of an inch thick ; yet, with this amazing thinnefs, are ftill a perfect cover for Silver wire ; nor can the beft microfcope difcover the leaft chafm or difcontinuity to admit any known fluid, or even light itfelf : but this depends altogether (incomprehenfible as it is) on its being free from Sulphur ; for mix but one grain of Sulphur with a thoufand of Gold, and it is malleable no longer. Neuman fays, "A fingle grain of Tin added to the "foregoing proportion of Gold, will have the fame effect ;" which, we fuppofe, muft be owing to the Arfenick that is concealed in the Tin. Yet Antimony, which contains much Sulphur, purifies it exceedingly well, and, by abforbing and deftroying all its heterogeneous affociates, promotes its liquefaction.

Although Gold has fo great a fpecifick gravity and folidity, yet its interftices and pores are found to be much larger than thofe of Silver, but not near fo numerous. Fine Gold is fo very perfect and durable, that it is never injured by lying in the ground for thoufands of years ; nor will any fire vitrify or deftroy it in a common natural fufion : yet by expofing it to the rays of the fun, in the focus of a peculiar large lens or burning glafs, it melts ; and being fufficiently continued thus in fufion or calcination, it emits a fume, and becomes a ponderous glaffy fubftance or fcoria of a purple colour. [Doubtful]

To render this Metal more hard than it naturally is, they alloy it with Silver or Copper ; yet it cannot bear to be mixed with Brafs, which makes it brittle, by means of the Calamy.

Platina is found, not in Ore but in fmall grains ; yet not pure, but mixt with a fhining black fand : there are likewife ufually mixt with it, a few fhining particles of a golden colour. When expofed to the fire by itfelf, it is extremely hard to melt ; but fufes readily with Gold, Silver, Copper, Lead, or Tin, and incorporates with them. A piece of it was put into ftrong Aqua Fortis, and kept in a fand heat for twelve hours, but

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when taken out, was no way corroded, and it preferved its firft weight. It appears then, that no body comes fo near Gold, in fixednefs and folidity. Cronftedt fays, it is heavier than Gold; and therefore the heavieft of all bodies hitherto difcovered: for though the fpecifick gravity of Platina, in the hydroftatical experiments made by Dr. Lewis, is found to be, to water, only as 17,000 to 1,000; yet, when melted with other certain Metals, its fpecifick gravity has, by an exact calculation, been found to be confiderably augmented, even fo much as to 22,000. If it could be made as ductile as Gold, it would not eafily be diftinguifhable from it by its other properties. It entirely refifts the vitriolick acid, which diffolves or corrodes every other known metallick body, except Gold; yet it differs from Gold, in giving no ftain to the folid parts of animals, nor ftriking a purple colour with Tin: it is, therefore, a fimple Metal, of a particular kind, effentially different from all thofe hitherto known. Platina hardens and ftiffens all Metals; one more than another, but Lead the moft. Tin bears much the leaft, and Gold and Silver the greateft quantity, without the lofs of their malleability. Though it is of an uniform texture, bright and fhining per fe, takes a fine polifh, and does not tarnifh or ruft; yet it makes Tin tarnifh foon, and Lead very quickly.

The fciences, commerce, and arts, muft receive great advantages from the application of a new perfect Metal to ufeful purpofes; which, to the fixidity and indeftructibility of Gold, unites a hardnefs and folidity almoft equal to thofe of Iron. We regret, that although large quantities of it are found in America, it is here fo exceedingly rare.

The caufe of the great fcarcity of Platina is, that the Spanifh miniftry have prohibited the fale of it, or the extraction of it from the Mines. Thefe prohibitions were certainly from good motives and wife intentions; for this Metal was no fooner known than it was employed for the adulteration of Gold, for which purpofe it is very fit, as it fuftains all the ordinary trials of Gold, has the fame fpecifick gravity, and renders Gold much lefs pale than Silver. The ufe of a Metal, with which frauds fo prejudicial might be committed with impunity, was neceffarily interdicted: but fince the beft chymifts in Europe have examined Platina, they have publifhed certain and eafy methods by which the fmalleft quantity of Platina mixed with Gold may be difcovered, and by which thefe Metals may be feparated in whatever proportion they may happen to be united. These methods may be seen in the memoirs of the chymists, who have examined this matter. We shall here only relate one of the most convenient and less troublesome. It is founded on a property, which Gold has, and Platina has not, of being capable of precipitation from Aqua Regia by martial Vitriol; and upon a property which Platina has, and Gold has not, of being capable of precipitation from Aqua Regia by Sal Ammoniack. When, therefore, we would discover whether Gold be allayed with Platina, let it be dissolved in Aqua Regia, and in this solution, which will contain both Metals, let some Sal Ammoniack dissolved in water be added, and the Platina will be precipitated in form of a brick coloured sediment. If on the other side, we would know whether Platina contained any Gold; let this Platina be dissolved in Aqua Regia; and to the solution, add a solution of martial Vitriol in water, upon which the liquor will become turpid, and the Gold will form a precipitate, which may be easily separated by decanting and filtrating the liquor. We may then affirm, that the reasons which induced the Spanish ministry to interdict the use of Platina, no longer exist; and we hope, that when they are once convinced of this, the publick will be no longer deprived of a substance which may be so advantageous to society. Dictionary of Chymistry.

Quicksilver, Mercury; which names it seems to claim from its relative velocity to the god Mercury, as well as the planet. This Metal, if it really can deserve that name, is almost simple as element, when in a fluid purified state. It is sometimes found in that form, and is reckoned preferable to that which is procured from the Ore of it, called Cinnabar. Mercury will amalgamate with all Metals, except Iron; and is, therefore, sometimes adulterated with Lead or Tin, because of their cheapness.

The detection of such frauds is of great consequence to the medicinal use of Mercury; and, therefore, that which is of a livid or pale colour, any way resembling powder, and runs into globules not exactly spherical, but oblong like little worms or tears, ought to be rejected. A very minute quantity of Lead largely diluted, we are told by Dr. Baker, is of pernicious and fatal consequences to some of those who take it into their bodies; insomuch as to have given name to a particular disorder in these parts, called the Colick of the Dunmonii, which was endemial in Cornwall and Devon in the year 1742, and returns every autumn

autumn more or lefs. I have met with thofe who have been tortured with this excruciating and uncommon diforder, which, though feldom mortal as a Colick, leaves behind it a fpafmodick Afthma, and an incurable Parefis. All this is occafioned by a few grains of Lead diffolved in the cyder which is made in leaden veffels. If Mercury thus ftored with Lead is taken into the human body, what is to be expected but that we may introduce the greater enemy to expel the leffer. To releafe the impure mixture with Quickfilver, you may rub a little of it in a marble mortar with fome vinegar : if the acid becomes a little fweetifh, Lead is certainly mixed with the Mercury ; if the vinegar is tinged, fome other Metal is to be fufpected ; but it is quite pure, when a little of it, held over the fire in an Iron ladle, totally evaporates. It remains to be remarked, however, that Quickfilver diffolves in all foffil acids. There is fcarce any cohefion at all in the parts of Mercury ; for a fingle grain thereof, by the action of a lens, is divifible into millions of globules invifible to the beft eye ; but by the application of a microfcope, they will afford a diftinct profpect of all the neighbouring objects. This incoherence of Quickfilver is the reafon why it is fo extremely volatile as to rife in a fume by the action of a very fmall fire ; but being mixed with Brimftone, it embraces it moft tenacioufly : and may then be reverberated by a great degree of fire, till it becomes fuch a red fubftance, as is fold in the fhops by the name of Factitious Cinnabar, or Vermillion.

We have no records to inform us that Quickfilver was ever found in this county ; but why this fertile Mineral diftrict fhould be exempt from the production of it, is no way clear : perhaps it might be found, if proper diligence and obfervation were ufed to get at it ; though indeed if it was fuppofed to be in any uncommon Stone of a red or gray colour, the common method of affaying would only ferve to fend it up the chimney in an invifible fume, which ought to be faved in clofe veffels.

The chief Mines for Mercury are thefe of Hungary, Spain, Friuli, and Peru. A Mine in Friuli is fo rich, that it always yields one half Quickfilver, fometimes two-thirds. The miferable flaves condemned to work in thofe Mines, are affected with tremors, and proceed to falivate ; then their teeth drop out ; and they are feized with pains all over, efpecially in their bones, which the Mercury penetrates ; and thus they die. A common precaution they ufe is, to hold a piece of Gold in their mouth to imbibe the effluvia and intercept their paffage into the body.

Dr.

Dr. Pope tells us of one he ſaw in the Mines of Friuli, who in half a year's time was ſo impregnated with the Metal, that on putting a piece of Braſs in his mouth, or even rubbing it in his fingers, it would turn white as Silver. Nor can this be wondered at, ſince it has been known to amalgamate the Gold ear-rings of the ſalivated wearer; and I have myſelf ſeen very minute globules in the rotten proceſſes of ſome bones, when I diſſected under the inſtructions of the accurate Dr. Hunter. Non ſemel in ſepulchris argentum vivum capitibus reperi. Anton. Muſa Braſavolus, in tract. de morb. Gallic.

Lead, Plumbum; alſo Plumbum Nigrum, to diſtinguiſh it from the Plumbum Album or White Lead, which was the name given by Pliny to Tin, although it is radically a diſtinct Metal. It is ſtiled Saturn, from the Planet of that name. It is ſeldom found malleable and purely metallick; for what have been taken for ſpecimens of native Lead, have produced, very often, three parts in four of fine Silver; from whence many have ſuppoſed, that there is no ſuch thing as native Lead: I have however ſeen two ſpecimens of it, in the poſſeſſion of Mr. Bennallack in this county.

This Metal ſeems to conſiſt in part of an impure leprous earth, of a ſulphureous nature; and it abounds alſo with ſomething very acid and corroſive, though cold, and cauſing paralytick complaints in thoſe who are much concerned in the melting of it. It may be diſſolved in many ſorts of weak acid menſtrua, much better than in thoſe of the greateſt ſtrength; and it will incorporate indifferently well with Quickſilver; but does not admit of ignition, for it melts in a very ſmall degree of heat.

The only Lead Ores which we have ſeen in Cornwall, are theſe four ſorts: firſt, the lead coloured bluiſh gray, of no particular form; ſecondly, the Antimoniated ſtriated glittering Ore; thirdly, the ſteel grained; and laſtly, the teſſellated or diced Lead: moſt of which are ſo extremely rich both for Silver and Lead, as to be well worth the working, if the Corniſh Lead Lodes were of a larger ſize, and more laſting than they generally are. The ſmall profits ariſing from this Metal hitherto wrought with us, have damped the ardour of our adventurers in their purſuit of it; and the Lead which has been diſcovered in the weſt of the county, has for the moſt part offered itſelf accidentally, when the Miners have been ſearching for Copper, with which it is more generally aſſociated than with Tin. For my own part, I have never feen it blended with Tin; but with Copper frequently; and always very rich for Silver, but in no quantity. Black Jack and Mundick are very clofe companions with it; but they, and Copper Ore, are all of them diftinct and difcernible from each other, in the Stone or Mineral ftate. In fearching for Copper Ore in Nanfkuke Downs, in a very promifing Goffan, we difcovered a leader, fix inches wide, of very rich Lead of the Antimoniated kind upon the north wall of the Lode. The Silver in it was plenty, infomuch as to render the Mineral worth £.18 or £.20 ℔ ton without any dreffing. It produced about a ton and half, and then totally difappeared.

It is a miftake of thofe who think that Lead becomes brittle by extracting the Silver from it, for it is rather more ductile. The deleterious properties of Lead I have already hinted at, in treating of Quickfilver; and I may obferve in this place, that any faturnine preparation given inwardly, muft be very hazardous, unlefs adminiftered under the direction of a fkilful practitioner.

In degree next to our provincial Metal, Tin, this ifland has been famous in the annals of paft ages for its peculiar production of Lead; and the kingdom in general has been more remarkable for the quanity produced, infomuch that Pliny faith, "In "Britain it runneth ebb in the uppermoft coat of the ground, "and that in fuch abundance, that, by an exprefs act among "the iflanders themfelves, it is not lawful to dig and gather "Ore above fuch a proportion fet down by ftint." And Sir Jofhua Child, in his difcourfe of Trade, tells us, "That our "Lead and Tin, which are natives, and by God's bleffing in-"feperably annexed to this kingdom, carry on much of our "trade to Turkey, Italy, Spain, and Portugal; befides great "quantities that are fold to Holland, to France, and to the "Indies, as is well known to all the merchants that trade to "thofe parts."

We have had many ancient Mines of Lead in Cornwall, particularly in Perran Zabulo; the Garres in St. Allen; and elfewhere. It is faid that the wars in France were carried on by the Silver of thofe and the Devonfhire Mines. The Ore in the Garres, when laft wrought about fixty years fince, was fo rich in Silver, as to yield one hundred ounces to one ton of Lead.

Silver,

Silver, Argentum, C Luna, from its attributed planet. Of all Metals, Gold excepted, this Metal is found moft frequently native; and it is, indeed, found in that ftate, more commonly than in Ore; and if you break the ftony Glebe or Mineral, you will fometimes find folid grains and lumps of malleable Silver contained in them. Silver is ufually mixed with other Metals, particularly in Cornwall with Copper and Lead, though but in a fcattered form and minute quantity, in the former no way adequate to the expence of extracting it.

Real Silver Mines diftinct from any mixture with other Minerals, we have none in England. We read of fuch, but they give us no produce to value ourfelves upon them; and indeed the two nobler Metals are foreign to our country, at the fame time the bafe and more ufeful Metals are beftowed upon us in common with the reft of the world. In our kingdom of Danmonii Silver Mines were difcovered in Edward the firft's time, when 337 men were brought from the peak in Derbyfhire to work them. Edward the third had great profits from them; and queen Elizabeth prefented a cup made of Silver to the earl of Bath, with an infcription upon it, from which infcription we muft conclude, that thofe Silver Mines, fo called, were abfolutely Lead Mines rich with Silver.

In Sweden they have a Silver Mine 150 fathoms deep, of which they have no records fo ancient as the firft difcovery of it; yet we do not apprehend it is a very profitable concern: neither are there any very rich Silver Mines in Denmark, although there is preferved, in the Royal Mufeum at Copenhagen, a piece of native Silver five hundred and fixty pounds weight, with three other fpecimens, above three and two hundred weight in each. There are likewife fome confiderable Silver Mines in Hungary; but none in Europe, it is likely, of a produce equal to the Hanoverian Mines, fome of which are worked at the charge of our moft gracious fovereign, and others let out to farm to his private and great emolument. I prefume the fingle Mine of Potofi in Peru, has exceeded every other quarter of the globe, in the richnefs and quantity of this valuable Metal. From this great vein, which is about fix feet wide, do iffue out fome fmall fprigs of little account, and yet here they refine thirty-eight millions five hundred thoufand pounds weight of Silver yearly; one pound of their Ore yielding one ounce of fine Silver, at which rate, they muft raife yearly two hundred fifty-fix thoufand, two hundred and fifty tons of Ore, before they can anfwer that

account

account in Silver: but by Gerard Molino's account, they muſt raiſe a great deal more. The vein runs directly north and ſouth, ſloping, hadeing, or underlying, in the hill towards the eaſt. They have an adit or level, which they were twenty-two years driving; but they do not diſcharge their Ore through it as formerly, becauſe it is become very long and crooked; therefore they carry up their Ore on their backs, each ſlave about fifty pounds weight in wallets, on ladders made of ox-hides, three and three in a row, one of them having a candle tied to his right thumb, to light the reſt. This work employs above twenty thouſand Miners, and is wrought day and night above a thouſand yards deep (ſee Acoſta in his Natural Hiſtory of the Indies): and ſeveral merchants that have travelled into thoſe parts relate, that this mountain, by reaſon of the numerous ſmelting houſes upon it, looks at a diſtance as if it were all on fire. (Waller on the Mines of Sir Carbery Price).

Cramer allows but four ſorts of Silver Ores, fundamentally ſuch; others being only impregnations of that Metal with foreign Minerals. The firſt is a vitrean Ore of an irregular figure, ſulphureous, and of a lead colour: the ſecond is a horny Silver Ore, ſemi tranſparent, like roſin in colour, of no external figure, but cloſely examined it conſiſts of very thin plates: the third is a red or ſcarlet Ore: and the fourth is of a light gray colour: and even this contains more Copper than Silver, even ſo as ſcarcely to deſerve the name of Silver Ore. Oftentimes Silver is found, like Wire, woven one within the other, between the rocks; and ſometimes it will reſemble Lace, by the Spaniards called Metal Machacada, which, from its deſcription, I apprehend to be like our native Filagree Copper.

Silver readily amalgamates with Mercury, and is eaſily diſſolved in genuine Aqua Fortis; but will not yield to Aqua Regalis, nor any other water impregnated with Sal Gem, Marine Salt, or Sal Ammoniack: theſe kinds of Salts, or their diſtilled waters, may ſerve to precipitate a diſſolution of Silver from Aqua Fortis, only for this ill conſequence, that Silver thus precipitated becomes very harſh and ſtubborn for fuſion, and is alſo rendered partly volatile, ſo that it evaporates conſiderably in the fire: this is that precipitation of Silver, which the modern Chymiſts call Cornua Lunæ. This Metal per ſe, is ſo ſoft, that it is expedient to allay it with Copper or Braſs to fit it for uſe.

Copper,

Copper, Venus, or Meretrix Publica; a common proſtitute from its reception of all menſtrua, other Metals having their peculiar diſſolvents. The acid particles of air will readily diſſolve Copper, and ſhew itſelf by an ærugo or ruſt upon the Metal. Oils themſelves diſſolve Copper by means of a Salt contained in them; for even the ends of tallow candles which the Miners leave under-ground, if touched by any cupreous water, will preſently be tinged green. This ſolubility is ſo extreme, that a ſingle grain diſſolved in ſpirit of Sal Ammoniack, will give a blue colour to 256,806 times its own bulk of clean water; and a faint, yet diſcernible one, to above 530,620 times its bulk. Copper in fuſion, will not bear the leaſt drop of water; for if the moulds be wet, it flies into numerous particles, like ſhot from a gun; and may deſtroy the perſons near it, of which I once met with a diſmal inſtance in one of the workmen at Hayle Copper-houſe.

Native Copper is frequently found in our Mines, near the day or ſurface, or commonly but a few fathoms deep; though there are ſome few inſtances of its being found very deep, particularly in the Mine of Cooks Kitchen, from whence ſeveral tons have been ſold to the Corniſh Copper Company, for immediate fuſion, as it came out of the earth.

On the ſide of a rivulet, ten leagues to the ſouth of Lake Superior in North America, there is a ſingle lump of native Copper, about four tons weight, free from any mixture but a few ſmall black Stones of an Iron nature, and ſome very fine grains of Cryſtal. Lake Superior, north from this lump of native Metal, is very wide. No vein of Copper was diſcovered on the ſouth ſide of the Lake, near this lump; but ſome few very ſmall ones on the north ſide, not worth the purſuit. This I had from two credible Miners of Redruth, who were ſent over to make diſcoveries in conſequence of this ſingular appearance.

We have before obſerved, that Copper is the moſt eaſily diſſolved of any Metal, even by common water; but certainly the diſſolution muſt be quicker, if that water is charged with acid or alkaline principles. Wherever Copper is found, there is always green or blue Vitriol, which are ſoluble and eaſily mix with every moiſture. The action of theſe principles, will, purſuant to their relative ſtrength, diſſolve and defecate the Copper particles they meet with, from their impure and heterogene admixtures; and keep them ſuſpended, till they are arrefted by the magnetick nidus of Goffan, when it is varioufly depofited, Stalactical, Guttatim, Machacada, or otherwife, as we may judge from the preffure, form, and fituation of it when found.

The Stalactical, is generally of a braffy colour; and fo is the bliftered buttony Ore, which is protuberant in a femi-circular form, occafioned by its defcent guttatim, into a foft and yielding bed of clay. But the vitriolick folution that forms malleable Copper, is the ftrongeft that can be obtained; therefore it is the more readily attracted by the ferruginous particles of the Goffan through which it percolates, and in very little time, affumes the place and form of its magnet, in quantity, cæteris paribus, as the folution and the nidus are more or lefs abundant. Being thus fituated and circumftanced, it likewife forms the Filagree, Laced, Machacada Copper of Alonzo Barba; which is the precipitation of Copper on the laminæ of Goffan, interfecting in all directions, and leaving unequal cavities, of various angles between the fepta: the ftructure, therefore, is very cellular, and makes it look like copper lace that has been burnt.

Thefe three forts, however, are very fcarce; and more of them are faved for the cabinets of the curious, than are melted in the furnace. Green Copper Ore is likewife very rare in Cornwall; and is feldom fo pure, as to be taken for a gem of the Turkois kind. Blue Copper is feldom met with, and in efteem only among the curious.

Gray Copper Ore is one of the richeft forts in this county. It looks like a kind of Lead; cuts with a knife, to a very fmooth face; and will produce the greateft quantity of Metal, of any Copper Ore.

Black Copper Ore, of a bluifh black, is alfo very rich. This is either folid, or fandy, being mixed with a light tender Cryftal and fandy Mundick. It is fo light, that it will not bear the ufual dreffing by water; but is generally griddled out and put to the pile for fale, as it rifes from the Mine. Being in this condition, it partakes of Mundick, Goffan, Earth, and Cryftal, fo largely, that the intrinfick value of the Ore will be carried off with it. It is faid, that formerly feveral thoufand pounds worth of this Ore was thus wafhed into the rivers, and difcharged into the north fea from the old Pool Mine. This kind of Ore in the Lode is oftentimes fo fair, that it may be raifed

and

and dreffed fit for fmelting, at the rate of a fhilling out of the pound, in the price it fells for ; nay I have known an inftance of its being done for ten pence. In this cafe, the end or ftool of the vein will run of itfelf, like fand, againft the workman with the ufe of his fhovel only. This Ore generally lies fhallow ; and feventy years ago, when Copper was not fearched for and little known among us, the Tinners threw it into the rivers as refufe, by the name of Poder, which fignifies duft, Mundick, or wafte. After it became well known, and was wrought for fale, it feldom exceeded £3 10s. ℔ ton for feveral years, while there were but one or two purchafers.

Red Copper Ore is rather fcarce, but it is valuable. There is a kind of red, fteel grained, goffany Ore, that looks very rich, and is worth from £14 to £20 ℔ ton, according as it is impregnated with Gal or Iron, which renders it harfh and ftubborn for fmelting. But of all Copper Ores, that which goes by the name of Peacock Ore, far furpaffes the reft for beauty and elegance of tint, while it is new and frefh ; for after it has been long expofed to the falts of the atmofphere, its beautiful colour fades away. The interior of this is yellow.

Of yellow Copper Ore, I have obferved four forts in general. The firft is found fhallow among black Ore, fmall, or not in large rocks ; and it can be freely fcraped into a yellow duft of a rich appearance. The fecond is the fine gold coloured flakey Ore, that is rich to the eye and in the crucible ; its real value may be from £12 to £15 ℔ ton : it is this kind of Ore which fhoots into diftinct and regular tetrahedrons, geometrically defined a triangular pyramid of four equilateral triangles : they are always fmall, diftinct, regular, and of the higheft polifh ; are very common, and as commonly overlooked by the fuperficial obferver. The third is a perfect brafs coloured Ore, which rifes in great quantities, and is reckoned the beft colour of any for its continuance in the Mine : when this comes up in plenty, the Miners pleafe themfelves with the fight of it for that reafon, although the value may be not more than from £7 to £10 ℔ ton. This coloured Ore feldom rifes before the vein is funk fifty fathoms deep, or at leaft not in great heaps ; the richer or more inconftant Ores being fuperincumbent. But the fourth and deepeft Copper Ore is of a pale yellow, pretty much corrupted with Mundick, and of an inferior price, being from £4 to £6 ℔ ton. The fuperior quantity, however, recompences for its quality and charges of dreffing ; for it is not

uncommon

uncommon for ſome of thoſe Lodes to produce from 300 to 400 tons of Ore monthly. It is very probable, that the ancients meant this kind of Copper Ore, when they ſpeak of their Native Braſs. Our Miners expreſs their ſenſe of the ſolidity and richneſs of ſuch a Lode, by ſaying, "She is as ſolid as a Braſs pan:" and Sir John Pettus, in his Fleta Miner. ſays, "Yellow Copper, for diſtinction, is properly called Braſs in the Stone."

The immature poor Ores of Copper, are conſtituted of Cryſtal, (Spar) Earth, Vitriol, Sulphur, Lead, Black Jack, Mundick, &c. and are vulgarly diſtinguiſhed by the names of Goſſany, Sparry, (Cryſtal) Mundicky, Peachy, Flookany Lodes; according as theſe appearances may predominate in the Stone or Mineral Ore, of which in their proper places. Some authors call the Ore of Copper, Cadmia Nativa; and yellow, or mundicky Copper Ore, they call Pyrites Ærofus, and ſometimes Chalcitis. The green ſpume of Copper, like Verdigreaſe, they term Chryſocolla, or Native Borax; and the blue coloured Spume, they call Cæruleum Montanum; and ſometimes both by the names of Ærugo Æris, or Copper Ochres. (Pliny, Hill, Da Coſta.)

Copper is to be found in moſt countries: of late years, however, Cornwall has produced its portion equal to moſt of them, to the amount of thirty thouſand tons of Ore in the year 1770; and for variety of colours none can exceed us.

By Chymiſtry we know, that alkaline ſalts produce a blue colour with Copper, which is changed into green, as ſoon as any acid is added; and from thence the reaſon is obvious, why a green colour may be found among calcareous Copper Ores, viz. when the vitriolick acid is in the neighbourhood of it. (Engeſtrom's notes upon Cronſtedt). Theſe menſtrua being differently qualified by one another, impart the grey, black, and peacock dyes; but when the menſtrua are clear and forcible, they borrow from the Copper, and impart the moſt piercing tints to precious Stones, making the Lapis Lazuli, the Sapphire, Emerald, Amethyſt, &c.

Copper Ores are vaſtly different from Tin Ores; for the former are always viſible in the Stone, though much inferior in quantity of Metal to the latter, except ſome of the grey Copper Ores, which contain as much Metal, as the beſt of the Tin. By what we have heard of the Ores of other countries, we believe,

believe, that thofe which we have in Cornwall are much poorer in kind, than any where elfe: perhaps, in other countries, the poor veins are neglected. This poverty of our Ores, as well as the wafte they are fo abundantly mixed with, is the fource of infinite profit to the laborious inhabitants; as both fexes of all ages are employed in dreffing and cleanfing them fo as to be fit for fale.

Iron, Ferrum; Steel, Chalybs; is called Mars, and has fo great a conformity with Copper, as not to be eafily feparated when foldered together; whence arifes that reciprocal friendfhip, which the poets feign between Mars and Venus.

It is fometimes, but very rarely, found native, and is the product of moft countries. Cornwall has likewife her Lodes of Iron, fome of them rich and near the furface, but they are generally fmall; and the charcoal for fmelting of it is fcarce; at leaft it is more profitably ufed for melting of Stream Tin. Thefe reafons, with our vicinity to fundry feaport towns, where all forts of Iron are imported at firft hand, and our natural attachment to Tin and Copper Mining, have occafioned a neglect among us of working our Iron Lodes.

Iron Ore is vulgarly called Ruddle, Reddeng, Oker or Ochre, according to its varieties of colour: the reddeft fort of it is thought to be a kind of Red Chalk. Some is ftalactical, and called Brufh Ore; and fome is fine, foft, and earthy, and called Smit. But thofe which are miftaken by many for diftinct forts of Foffils, are the Hæmatites, or Bloodftone; the Magnes, or Loadftone; the Smiris, or Emery; and Magnefia, or Manganefe, &c. all which are feparate fpecies of Iron Ore.

It is the hardeft, drieft, and moft difficult to fmelt, of all Metals, and will ignite a long time before it will flow; yet it is the only Ore that ftrikes fire with Flint. Malleable Iron is very difficult to be melted, without the addition of Antimony, or fome other fulphureous fubftance; it will not unite with Quickfilver in any wife; but is eafily corroded and acted upon by every fort of acid menftrua, and by moft if not all forts of Salts. This Metal, in the firft fmelting, is called Caft Iron, which is brittle; but is perfected by annealing it in the fire, and then by hammering of it, though gently at firft, when it becomes malleable. Steel is made of the beft and pureft Iron, by cementing it with the hoofs and horns of beafts, and fuch excrefcences, which contain a volatile animal Salt ; and being ſo cemented, they quench it in water, whereby its pores are ſo greatly conſtringed, that it immediately grows ſo hard as to acquire the properties of Steel.

Of all the ſubſtances concurring to form the terreſtrial globe, Iron ſeems to have the greateſt ubiquity ; as it is well known to enter into the compoſition of Earth, Stone, Plants, and Animals, ſo truly, that from the aſhes of either you may viſibly and ſenſibly perceive its exiſtence, even ſo as to be diſcovered in various ſecretions from human blood, in milk, urine, fat, &c. as may be proved by drawing a Loadſtone (whoſe property it is to attract Iron only) over their calx, aſhes, or reſiduum, when the Iron particles will be drawn out of them, and adhere to the Magnet.

Iron is the moſt uſeful to human life : it is our defence and ſecurity ; and no arts or manufactories could exiſt without it. Navigation, trade, and commerce, would be at a ſtand ; and even the art of diſcovering other Mines and Metals, could not be practiſed without it : ſo that this, which is conſidered as the baſeſt of Metals, is indiſpenſably neceſſary for all the various uſes of mankind. Beſides the innumerable kinds of inſtruments made of it, it furniſhes excellent remedies in many diſeaſes : by its figure and gravity with the human blood, it becomes a deobſtruent and reſtorative in cold and relaxed temperaments ; but in full and ſanguine habits, it is inflamatory and dangerous, unleſs preceded by veneſection and other evacuations.

Tin, Stannum ; Jupiter. טיט in the Chaldee ſignifies ſlime, mud, or dirt ; and when the Phenicians came into Cornwall, and ſaw this Metal in its ancient ſlimy ſtate, they called it, " The Mud :" from thence the name, Tin, (in Cornu-britiſh Stean, in Latin Stannum) has proceeded, and is ſtill continued. Some of the ancients called it Plumbum Album, White Lead, to diſtinguiſh it, perhaps, from common Lead. It was by them called White Lead, from its colour and purity ; but they did not know it to be, radically, another Metal. We find no Latin name in authors for the Ore of Tin ; probably, becauſe the ancients were unacquainted with it as a Metal characteriſtically diſtinct from Lead. Neither do the Tinners or Miners call it Tin Ore ; for they give it the name of Tin-ſtuff, as it riſes out of the earth ; and they diſtinguiſh it by ſeveral incidents which happen often to it, either from the Ores, or crude Minerals

intermixing

intermixing with or corrupting of it; as Pryany, Peachy, Goffany, or Mundicky Tin-ftuff: or elfe according to the degrees of finenefs, or fmallnefs, that it is brought to, by ftamping of it to a powder. Being pulverized fine, wafhed, and cleanfed, it then has the name of Black Tin; and is, therefore, fit to be fmelted into White Tin, or Metal. It does not acquire a real blacknefs by its pulverization, but is of various colours according to the colour of the ftuff with which it is principally mineralized: it moft commonly, however, partakes of a brownifh or dufky liver colour; and obtains the name of Black Tin, in contradiftinction to its metallick colour and properties.

The exiftence of native Tin remains a doubt among the curious, to this day; but I never heard one reafon advanced, why it cannot exift. Although Tin is the lighteft of all Metals, its Ore, when rich, is the heavieft of all metallick Ores; info-much as fometimes to have a greater fpecifick gravity, than a piece of pure Tin of the fame fize: this is probably occafioned by the abundant quantity of Mundick with which it is combined.

The Ores of Tin may be generally claffed into Shode, Stream, and Bal or Mine Tin. The Shode is disjunct, and fcattered to fome declined diftance from its parent Lode; and is pebbly, or fmoothly angular, of various fizes, from half an ounce to fome pounds weight. Stream Tin Ore is the fame as Shode, but fmaller fized, arenaceous, and in its ftate, is in the form of fmall pyramids of various planes, very broad at the bafe, and tapering to a point at the top. In polifh and colour, thefe grains, fo called, are gloffy jet black, refinous, or red, and are the pfeudo garnet, ruby, topaz, &c. The largeft fingle grain of Tin that we remember to have feen, is in the poffeffion of Mr. Giddy, Surgeon, in Penzance, which weighs two ounces, four pennyweights, and twenty-two grains. Stream Tin Ore, is the fmaller loofe particles of the Mineral, detached from the bryle or backs of fundry Lodes, which are fituated on hilly grounds, and carried down from thence by the retiring waters of the diluvium, or floods of fubfequent dates, being collected in large bodies or heaps, in the valleys. In the folid rock of the valley, there is no Tin Ore; but immediately upon it, is depofited a layer of Stream Tin of various thicknefs; perhaps over that, a layer of earth, clay, gravel, &c. and upon that again another ftratum of Tin Ore; and fo on fucceffively, ftratum fuper ftratum, according to their gravity, and the different periods

periods of their coming thither, to the depth of eighteen feet at a medium in St. Auſtell Moor. In St. Blazey Moor, at the depth of twenty feet, they have what they call Stream (Tin Ore) about five feet in thickneſs in the bottom, great part of which had been anciently wrought before Iron tools were known, ſeveral wooden pick-axes of oak, holm, and box, having been lately found therein. Over this they have a complete ſtratum of black mud, fit for burning; on this a ſtratum of gravel, very poor in Tin; on this another ſtratum of mud; and uppermoſt gravel again.

Bal or Mine Tin Ore, frequently riſes very rich; and inſtances are plenty, where it has been diſcovered in the richeſt and pureſt ſtate imaginable. Under ſuch circumſtances, it has been carried to the ſmelting-houſe, as it came out of the earth, and the proprietors have received ten parts in twenty of it in Metal, the ſmelter having taken to himſelf perhaps one part more for his expence and profit. Polberou in St. Agnes, which belongs to the Donnithorne family, produced great quantities formerly. In the year 1750 it is ſaid, one rock of Tin from that Mine, weighed 1200 pounds, and produced one half in Metal, clear of all expence to the owner, who gained £100 ℔ diem for ſome conſiderable time.

I obſerve that this kind of rich Tin Ore, which conſiſts of the blackeſt grains or Cryſtals, is uſually found at a moderate depth, or within the day ſide of forty fathoms. Grouan Lodes; ſo called from their participation of the nature of the adjunct and incumbent ſtrata, do moſt uſually produce thoſe very rich Cryſtals. But a lofty ſolid unformed Tin Ore, is commonly the production of all kinds of ſtrata; and, according to my obſervation, is in itſelf more independent of any contingent influence. I have ſeen the ſame ſolid lumps of black and duſky liver coloured Tin Ore ariſe equally alike in form, colour, and appearance, from Lodes in Grouan, Moorſtone, Ironſtone, Kellas, or Cryſtal ſtrata. Goſſan never exhibits a rich ſhew of Tin Ore; for it is in that nidus more diſſeminate and minute. It ſeldom continues in Goſſan, above thirty fathoms from graſs. But if we deſcend from the loftineſs of Tin Ore before deſcribed, we may find it, although inviſible to the inexperienced Miner, very rich and ſmall grained; in which poſiture it is ſcarcely known, but by the exceeding gravity of the Stone in which it is enſhrined, and the different colour thereof from the adjacent ſtrata. Sometimes it is in blue, gray, black, or brown coloured

Lode-ſtones,

Lode-ftones, extremely fmall; fometimes veined in the Stones, and branchy throughout the Lode, whereby it may be feparated and forted as it rifes, to the faving of much expence in dreffing: in other places it may be priany, peachy, flookany, or mundicky, with which it may be either very prevalent or fcanty; but in the latter, and where Copper participates, it muft be well burnt before the true value of it can be known.

This Metal feems to be earthy and very fulphureous; almoft foft and pliable as Lead, but more white and beautiful. Bend a piece of pure Tin, or bite it hard, and it will give a crafhing noife or ftridor; but its purity is beft known by obferving the whitenefs or delicacy of its grain, when broke off fhort. Tin, like Lead, is more eafily diffolved in a weak acid menftruum, than in a ftrong one. It may be eafily amalgamated with Quickfilver, and melts almoft as readily as Lead; therefore, it will not bear ignition. It is not naturally very fonorous; but becomes fo, when properly commixt with Copper. It will not eafily endure the teft by fire; for as foon as the heat becomes violent it affumes the form of a ftubborn afh or calx, which foon lofes its fluidity, and is changed into a powder called Putty; which powder is alfo made by calcination of Tin, but is reducible into Tin again by melting with a proper flux.

Befides its ufefulnefs in utenfils per fe, it is alfo neceffary for covering the infide of Copper, Brafs, and Iron veffels, to preferve them wholfome for culinary ufes; whence there is a large confumption for tinning Brafs ware and the like: it is ufeful alfo in foldering; but I believe the compound Metal of Pewter, of which it is the principal ingredient, is preferable for that purpofe. Befides its domeftick ufes, it is a neceffary article, when diffolved in Aqua Fortis, for the new fcarlet or Bow die. And if I am rightly informed, our moft beautiful and lafting coloured fine cloths owe their fuperlative excellency to the retentivenefs given by our fineft grain Tin; infomuch, that the Englifh fuperfine broad cloths, dyed in grain by the help of this ingredient, are become famous in all markets of the known world.

It is more than probable, that the purple die of the Tyrians gained the very great reputation it had among the ancients, in great part, if not wholly, from their ufe of our Tin in the compofition of their die ftuff, as the Tin trade was folely in their own management and direction. I think the known facts of its being their monopoly, the exceeding ufefulnefs of it as one of the non-colouring retentive ingredients, and the fame in all parts of the world of the unfading colour of that purple which is fuppofed to be given by the juice or faliva of a certain fhell fifh called Purpura, do very much preponderate towards my conjecture.

We may be certain, that almoft the fole traffick to this ifland four and twenty centuries ago, was for this Metal; and we have before obferved, that in thofe very early ages, our Tin was fold to the Phenicians, who (like the prefent Hollanders, the grand carriers of Europe) tranfported the commodity in their bottoms to all foreign parts. "Tyrus, O thou that art fituate at the "entry of the fea, which art a merchant of the people for "many ifles." (Ezekiel).

Jefus the fon of Sirach, the author of Ecclefiafticus, lived 247 years before Chrift. In fpeaking of Solomon's glory, chap. xlvii. verf. 18, he fays, "By the name of the Lord God, "which is called the Lord God of Ifrael, thou didft gather "Gold as Tin, and didft multiply Silver as Lead." Which fhews that Tin in thofe days, viz. 247 years before Chrift, was exceedingly plenty in the Holy Land. And it is remarkable, that Tin and Lead in this place, are both mentioned, and diftinguifhed; fo that the latter cannot be taken or meant for the former, as they have been miftaken and confounded together for one Metal by others, though characteriftically different. By the fhips Solomon fent out, he had a return in one voyage only, of no lefs than 420 talents of Gold; therefore it is expreffed, 1 Kings x. 27. "Money was in Jerufalem as Stones "for plenty." How vaftly plentifull muft Tin have been then in Jerufalem, to be fpoken of in the above figurative way?

We cannot, however, fay pofitively, that no other country produced this Metal in thofe days; but if it was then known in other nations, it was very little fought after, and was eftimated as a ftaple by no country except Cornwall. Pliny fays, it was found in Gallicia and Lufitania, but not at a depth or in quantity to merit much attention. A Tinner, in the time of Richard earl of Cornwall and king of the Romans, upon fome difguft at home, went over to Saxony, and taught the natives to feek for Tin, and render it merchantable: they have to this

this day ſome workings for Tin, though of no further account, than for their own conſumption. Alonzo Barba, ſays, that they had rich veins of Tin at Oruro and Potoſi; but their vicinity to ſuch immenſe Mines of Silver, is the reaſon of their being never worked to any purpoſe. A great deal of Tin has been imported into Europe theſe latter years from the Moluccas, ſome bars of which the writer has ſeen equal to the beſt Corniſh Grain Tin.

BOOK

BOOK II.

CHAP. I.

Of the Strata of the Earth, and the Fiffures in which Metals are found, their Direction, Inclination, or Underlie.

BEFORE we difcover the receffes of our Metals and Minerals, it will be convenient for the reader to have fome knowledge and acquaintance with the circumjacent Strata, which enclofe the objects of our enquiry: purfuant, therefore, to the plan of a late ingenious author, upon our entrance on the fubject before us, we will examine the fhell firft, and then confider the kernel.

The Strata of different countries are various; and from enquiry I cannot find that they are influenced by the atmofphere or climate in any degree: and they are not only various, but alternate in their extent, breadth, and depth, in all parts of the world. In the Mining countries, they are found of different denfities and gravity, Stratum fuper Stratum throughout; fome hard, fome foft, then hard and foft again. Thus we may find uppermoft, a Stratum of Granite, or Moorftone-rock; then a fofter Granite, called Grouan; now Kellas; and fo on, to the concave of the grand abyfs. Half a mile diftant, the layers of Rock or Stone will be altogether changed in their pofitions or complexions; whereby no abfolute rule can be formed, to decide upon the certainty of meeting with this or that Stratum, before the induftrious Miner has laid them open to view.

I fhall not attempt to defcribe all the Strata that are to be met with; but fhall confine myfelf to Cornwall, and even that part of it which is difpofed for Metal, within compafs of my own perfonal infpection.

The general law of attraction evidently appears in the diftribution of our Strata; and their fpecifick gravities feem not to determine them fo much as might be expected: whence we

may

may argue, that when ſolids and fluids formed, (and from a ſtate of chaos became divided into diſtinct bodies) the parts of the former being deſerted by the latter, muſt needs grow cloſer together. But the maſſes of Earth, Stone, and Clay, were not at this time merely paſſive; they formed larger and more compact bodies, every where, according to the mutual attraction of their ſimilar parts within proper diſtance. It muſt be further obſerved, that as all ſimilar parts ſtruggled to come into contact with each other, ſo at the ſame time they deſerted, repelled, and expreſſed all diſſimilar and contending particles; conſequently, maſſes of different natured particles, ſeceded and fled from each other, every party (if I may be allowed the expreſſion) tending to unite and combine with its like. Dr. Worthington, in his Scripture Theory of the Earth, ſays, "All matter gravitates towards all matter; ſo all homogeneous "parts of matter gravitate ſtill more powerfully towards each "other, whereby they are more cloſely united and compacted "together, according to their ſpecifick textures. Each there-"fore will aſſort themſelves, and aſſemble with their kinds "reſpectively." Theſe cauſes then, viz. the deſertion of moiſture, the union of ſimilar, and the mutual repulſe of diſſimilar particles, muſt all have contributed to form the maſſes of our terraqueous globe into ſuch ſeparate portions as we now find them in. This accounts for the diverſe diſtribution of our Strata, which by this theory will not be founded upon chance or caſualty, as was the caſe by Mr. Hawkſbee's return to the Philoſophical Society in the year 1712, when he bored to the depth of thirty Strata of a coal pit.

However, in the natural claſs and order of our Strata, I ſhall make my obſervations in proportion to their hardneſs and ſolidity, beginning with the tendereſt firſt.

Soft Grouan, though a Stratum, can ſcarcely be called a Stone; for it is rather a ſandy or priany Stratum of Moorſtone gravel, not cemented together, but lax, arenaceous, and mixed with diſperſed Stones of Granite. It generally lies at the extremities of the Moorſtone Stratum, or hard Grouan. In ſome places it is ſo fair or ſoft, as to run out againſt the workmen, and requires a great deal of timber to ſecure it; but notwithſtanding this, it encloſes numbers of Tin Lodes of conſiderable value in the pariſhes of Wendron, Camborn, Crowan, Redruth, Gwenap, Illugan, &c.

Slate is common to many parts of our county ; but, in quality of Slate, is not difpofed to fecerne Mineral juices, although fome thin efflorefcencies of Mundick have been feen on the edges of the famous Delabole Slate-ftones. The Slate, or Shelfy-ftone, is always uppermoft next the loamy foil ; but, in depth, it enters into the nature and confiftence of real Killas.

Of Killas I have obferved fix forts common to us, the white, the red, the yellow, the brown, the cinereous or bluifh, and the deep blue. The firft is very white and tender, and from its exceeding tendernefs is called Fair Ground ; it requires much timber and boards for binding, and fecuring it from filling the Mine, and endangering the workmen's lives. The red is not fo fair, but is well difpofed for Copper, or Tin Lodes ; the latter preferably. The yellow is but indifferently difpofed for either. The brown, which has various fhades of lighter and deeper colours, is generally a hard Stone, and contains Lodes of Tin more commonly than Copper. But of all the Killas, the cinereous or pale blue is moft defirable, as the enclofing Stratum of a Copper Lode. We find it the moft common and agreeable cheft that enclofes our cabinets of jewels. Conftant experience will incline us to give this Stratum the preference to all others for Copper Mines, on account of its generally accompanying a rich Mine ; and becaufe it is tender and agreeable to work upon in the finking of fhafts and the driving of drifts or adits out of the Lode. It is this kind of Killas which we call Feafible Ground, i. e. to be eafily broken, and yet firm enough to ftand without the fupport of binding with timber and boards. However this will oftentimes, by infenfible degrees, wear out as we call it, and become a deep blue, hard, unkindly, and coftly Killas, neither favourable to the Mine nor the labourer. It will require great addrefs, and much gunpowder fometimes, to break and make way through it. A Killas in its beft ftate, is foft, tender, fleaky, and fatty ; will cut to any form underground, and requires no timber ; but if it is hard and untractable, and works in very fmall fhreds of Stone, it is unfavourable to work or enclofe Metal.

Elvan, at a fhallow level, is a gritty kind of Stone, moft like a coarfe Freeftone, but in depth is exceeding hard. The two moft common colours of this Stone are a bluifh grey and a yellow Freeftone. It commonly yields great quantities of water ; and we take it to be of the fame kind with that Stone which lies on the Culm veins in Wales. It fometimes runs in a direction

tion north, and fouth, contrary to the metallick veins, which generally keep their courfe through it, but the Lodes are frequently fqueezed up by its accompanying them fome length in their courfe, or are fplit into many fmall branches. Sometimes the Fiffures or Lodes are thrown fhort on one fide, out of their direct courfe as it were, by the extreme hardnefs of this Stratum, and afterwards they recover their courfe again. At other times the metallick veins are elevated or depreffed by it, though they always recover their former direction, and unite again; for this Stratum wears out at a great depth, and is fucceeded by Killas.

Moorftone or Granite. The name of Granite, which thefe Strata have univerfally obtained, is a modern name given them by the Italian writers, on account of their being concreted into grains, or in a granulous ftructure, and not compact and uniform as the Marbles, &c. are; thence Granita i. e. è granis compofita. The parts of Granite are not homogeneous, but are different concretions of Quartz and Micæ. The varieties are compofed of black and white Talc, a dead earth not unlike the white Boles or Pipe Clay, and true Cryftal.

We have five forts common to us, viz. the white, the dove coloured, the yellow, the red or Oriental Granite, and the black or true Cornifh N° 1 of Hill. Either of thefe as a Stratum, is called a Hard Grouan Country, (in the Swedifh tongue Graberg, and Graften) and the two laft are frequently fo hard and invincible as to tire the patience and pocket of the adventurers, and the labour of the workmen. Grouan Strata are difpofed for Tin, which in fuch fituations is generally of a rich quality, or cannot long be fought after or wrought in its almoft impregnable walls. They are feldom likely for Copper Ore; and were long thought to be wholly adverfe to that Mineral, till the great Mine of Trefavean proved that rule exceptionable.

The Ire-ftone, or Iron-ftone, is by much the hardeft of all Strata, and borrows this name from its extreme hardnefs, and not becaufe it contains Iron. It is of a dark bluifh colour, like Lead that has been long expofed to the weather; and ufually fo hard, that it muft be wrought with Steel borers, and then blown by gunpowder. It often keeps a courfe eaft and weft like a Lode, but is commonly very wide; and therefore it is very tedious and chargeable, where an adit muft be driven acrofs through it. It is this Stratum that is uppermoft through great part

part of the middle of Camborn and Illugan pariſhes, where many principal Copper Mines are encloſed in it. Tin Lodes are very ſeldom found in Ire-ſtone, but very rich Copper Lodes in many places are natural to this Stratum or country. We do not obſerve that it ever gets into the Lodes themſelves, although there are ſome dark hard peachy Stones very like it in ſome Lodes. The author of a familiar diſcourſe concerning the Mine adventure, ſays, "It is a conſtant obſervation amongſt all "Miners, that the harder the rock, the richer the Mine; na-"ture generally makes the caſe ſtronger or weaker, according "to the richneſs of the treaſure therein contained: for where-"ever the ſides of a vein are cracked and broken, the mineral "water that feeds the vein, runs off, and the vein proves dead "or very poor: but when the ſides of a vein are ſolid and firm "without cracks, the mineral feeder impregnates and enriches "the Mine, and the ſame proves quick and rich in Ore." This cannot be a general rule, for our theory and obſervation prove its falſity. It cannot depend upon the confinement of mineral water in one particular place, that a Lode ſhall be rich in Metal, ſo much as upon the ſtrength and peculiar attraction of the nidus through which it circulates; for we conceive the attraction to be inſtantaneous: therefore, water charged with mineral ſalts or particles continually paſſing through a vein, will more abundantly impregnate that vein, than if its principles are decompoſed, and the water is left pure and unmixed. This is the reaſoning of moſt experienced Miners; for when a rich Lode of Copper, &c. is cut with abundance of water following the diſcovery, they always declare, "It is a very promiſing "circumſtance."

The foregoing Strata are only common to Tin and Copper Lodes in this county, and if we have not ſpecified more which may be thought of by the diſcerning Miner, we will nevertheleſs take upon us to ſay, any others that may be mentioned will only prove to be varieties of ſome of theſe. We cannot learn, that there are either Chalk, Marble, or Limeſtone, in any part of our mining Strata; conſequently real Spar is foreign to our country.

Now when the general aſſimilation of kindred particles happened, and ſolid bodies were ſeparated from fluid; between the diſſimilar, certain cracks, chinks, and Fiſſures, in various directions and contortions, were effected at their extreme angles; but as the matter of each Stratum became more compact and denſe denfe by the defertion of moifture, each Stratum within itfelf had its Fiffures likewife, which for the moft part being influenced by peculiar diftinct laws, were either perpendicular, horizontal, or oblique; but at the angles of different Strata, were fhattered, ragged, and in all directions. "Linnæus wonders at "the nature of that force, which fplit the rocks into thofe "cracks; but probably the caufe is very familiar; they were "formed moift, and cracked in drying." (Hill). This may account for the roughnefs or fmoothnefs of the walls of fome Lodes. But whether this theory is difputable or not, we are neverthelefs certain, that cracks, or Fiffures, are abundant in all parts of fubterranean matter; and likewife that thofe very Fiffures are the wombs or receptacles of all Metals, and moft Minerals.

The comparative fmallnefs of the largeft Fiffures to the bulk of the whole earth, is really wonderful. In the fineft pottery we can make, by a microfcopick view, we may difcover numerous cracks and Fiffures fo fmall, as to be impenetrable to any fluid, and impervious to the natural optick: therefore if a globe of earth, whofe circumference is 24,000 miles, is only fplit into the very fmall comparative clefts we behold, how wife and good muft that Creator be who hath fo contrived by his laws of attraction, repulfion, and gravity, to fix and fettle the limits of his creation within their juft and proper bounds! No; the great Architect, who contrived the whole, determined the feveral parts of his fcheme, fo to operate, as that one ufeful effect fhould become the beneficial caufe of another. God provided for the ufes of things in his firft ideal difpofition of them; and their refpective beneficial ufes flowed naturally from each other, thus aptly difpofed. Hence it happens, that matter could not contract itfelf into folid large maffes, without leaving Fiffures between them; and yet the very Fiffures are as neceffary and ufeful as the Strata through which they pafs. They are the drains that carry off the redundant moifture from the earth, which, but for them, would be too full of fens and bogs for animals to live or plants to thrive on. In thefe Fiffures, the feveral ingredients which form Lodes, by the continual paffing of waters and the menftrua of Metals, are educed out of the adjacent Strata, collected and conveniently lodged in a narrow channel much to the advantage of thofe who fearch for and purfue them; for if Metals and Minerals were more difperfed, and fcattered thinly in the body of the Strata, the trouble of finding and getting at Metals (thofe neceffary inftruments of art and commerce and the ornaments of life) would be endlefs, and the expence of procuring exceed the value of the acquifition.

" Thefe Fiffures," fays Agricola de Ortu, &c. " were the " channels through which the waters retired at the time of the " creation into the ocean, when the dry land made its firft ap- " pearance:" and Woodward in his Nat. Hift. thinks they are breaches made in the Strata by the retiring waters of the deluge, prior to which æra (according to his hypothefis) there could be neither Fiffure nor Lode. The opinion of the former is eafily refuted; for the walls of the Fiffures in fome places are too hard to be overcome, and to yield to the power of any current of water; and in other places too fair and tender to endure the force of fuch a torrent: befides, their eaft and weft direction, have not that tendency, in our parts, to difcharge into the ocean, as they might feem to fhow, if their courfes made for St. George's channel in the north, and the Britifh channel in the fouth. With regard to the latter opinion, our Shodes will notorioufly evince the miftake; as the Fiffure muft be antecedent to the matter of its contents, whofe Shodes, it is generally believed, were feparated from the fuperior part of the Lode by the retiring diluvium.

The infide of thofe Fiffures are commonly glidered or coated over with a hard, cryftalline, earthy fubftance or rind, which very often in breaking of hard Ore comes off with it, and is vulgarly called the Caples or Walls of the Lode: but I take it the proper walls of the Lode are the fides of the Fiffure itfelf, and not this coat, which is the natural plaifter upon thofe walls, furnifhed perhaps by the contents of the Fiffures, or from oozings of the environing Strata. We can prefently fee the breadth of a Lode or of a branch, by the incrufted fides of the Stones of Ore, if brought whole to grafs, although we were never under-ground to take the meafure of it; therefore it is common to fay, " I perceive the breadth of this or that Lode, " to be fo many inches wide; becaufe here are the fmooth " walls or caples affixed to and broke off with the Stones of " Ore." But this can be only in fmall Lodes, and hard Strata, where the Lode breaks ftoney. If a Lode is inclinable to yield any fort of Ore, it is the more promifing provided the caples or walls of the Lode are regular and fmooth, or at leaft if one of them is fo; but if they are uneven and rugged, it is the lefs encouraging. There are, however, but few Lodes or Fiffures that make regular walls, until they are funk on a few fathoms.

Thus,

Thus, the medullary or inner part of a Fiſſure, in which the Ore lies, is all the way environed and bounded by two walls or coats of Stone, which are generally parallel to each other, and include the breadth of the vein or Lode; ſo that when the Miners dig down or along in a large Lode, then the roof, i. e. the upper, the hanging wall, or incumbent wall of the Lode or Fiſſure, is (in a certain proportion according to its inclination or underlie) over their heads; and the lower, or other wall or rind, is under their feet: and further, whatever angle of inclination ſome Fiſſures make at firſt in the firm ſolid Strata, they ſeldom vary from the ſame in depth: there are, however, ſome exceptions to this rule. Some Fiſſures are very uncertain and different in ſize; for they may be very ſmall near the ſurface, or very wide in depth, and vice verſa; but as to the regular breadth or largeneſs of Lodes in their length or direction, they generally make a great variation; for although a Fiſſure may be many fathoms wide in one particular place, yet, a little further eaſt or weſt, it may not perhaps be an inch wide.

This variation may happen from ſeveral cauſes, but more eſpecially in very compact Strata, when the Lode or Fiſſure is ſqueezed, as it were, through means of hard rocks, which ſeem to compreſs and ſtraiten the Fiſſure. However, a true Lode, Courſe, or Fiſſure, is never entirely cut out or deſtroyed by hard rocks or Strata; for the Fiſſure always continues through the hardneſs, yielding a rib or ſtring of metallick Ore, or elſe of a veiny ſubſtance; which often ſerves for a leader for the Miners to follow, until it ſometimes brings them again to a large and rich part of the impregnated Fiſſure: all which variety of ſize in the length, breadth, and depth of Fiſſures, ſhews that they are the immechanical operations of nature, to fix and ſettle different congeries of mixed bodies into their peculiar ſhapes and poſitions.

As to the length and depth of Fiſſures, perhaps they ſeldom admit of any period or limitation; for none can tell how long or how deep they reach: but in regard of their breadth, thickneſs, width, or largeneſs, they are limited and various. Though the depth of Fiſſures is unlimited beyond the power of man to follow after, yet it appears in general, that their fruitfulneſs for Metal is diſtinct and limited. The richeſt ſtate for Copper is between forty and eighty fathoms deep, and for Tin between twenty and ſixty; and though a great quantity may be raiſed of either at

fourſcore

fourfcore or one hundred fathoms, yet the quality is often decayed and dry for Metal.

The Fiffures then of Cornwall, which are productive of Metals and Minerals in their progrefs or direction, are extended eaft and weft; or, more properly fpeaking, one end or part of the Fiffure points and runs weft and by fouth, or elfe weft and by north, or thereabout; and the other end looks or tends eaft and by fouth, or eaft and by north: and thus they often pafs through a confiderable tract of country, with little or no variation in their directions, except they are obftructed by fome intervening caufe; of which hereafter, when we come to fpeak of the interruption of Lodes, &c. Henceforward we fhall not always take notice of their deviation from the cardinal points of the compafs; but, for the moft part, fhall confider them as tending eaft and weft, as the only Fiffures which are filled with Tin and Copper Ores in Cornwall.

Befides this eaft and weft direction of Fiffures, there is yet another of a contrary manner and tendency, which the Miners properly name, the underlying of the Lode, or the Hade. This is the deflection or deviation of the Fiffure from its perpendicular line, as it is followed in depth like the flope of the roof of a houfe, or the defcent of the fide of a fteep hill. Inftead of its tending directly downwards to the center of the earth, it inclines either to the north or the fouth, or nearly fo. Suppofe, for inftance, one fide of the roof of a church to be a Lode bared of its incumbent Strata: the length of it eaft and weft, will fhew what I mean, by the direction of the Lode or Fiffure; and the flope or fide will explain its inclination or tendency downward; that is, the north fide of the roof underlies north, and the fouth fide underlies fouth: fo that if a Miner fhould dig down perpendicularly where he firft began, or cut the Lode, then it would foon be gone away from him, either to the north or to the fouth: therefore, when it happens thus, they are often obliged to fink new fhafts or pits on the underlie or inclination of the Lode, to cut it in depth, for the eafe and conveniency of winding or drawing up the water and Ore in a perpendicular line. This underlying varies much in different Lodes, and fometimes alfo in the fame Lode; for it will often flope or underlie a fmall portion different ways, as hard Strata on either fide may feem to force it. Some Fiffures do not alter much from a perpendicular; and fome do underlie a fathom in a fathom; that is, for every fathom which they go down in depth, they

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are alfo gone a fathom further to the fouth or to the north, which ever way the inclination or underlie may be. Other Fiffures, again, underlie fo faft, or obliquely, that they differ not much from an horizontal pofition, and they are thence called Flat Lodes, or Lode Plots. There is another fort of Flat Lode or Lode Plot, which underlies irregularly with refpect to other Lodes or Fiffures; for this underlies or widens horizontally for a little way, and then goes down perpendicularly not unlike ftairs, with only a fmall ftring or leader to follow after; and thus they alternately vary, and yield Ore in feveral flat or horizontal Fiffures. Yet this kind of Fiffure is very rarely met with, and is wrongly called by the Tinners, a Floor or a Squat, which properly fpeaking is a hole or chafm impregnated with Metal, that makes no continued line of direction, or regular walls; nor yet goes down any confiderable depth; for when a Floor of Ore of this fort is dug away, there appears no footftep or fign of a vein or Fiffure, either under foot, or pointing or leading any where elfe. Alonzo Barba, in the Spanifh tongue, calls it a Sombrero, which fignifies a Hat or a Heaped Mine, where Metal is found in a heap together. In Cornwall, they call it a Bunny of Ore or Tin; and fometimes "The Pride of "the Country;" which laft epithet we apprehend more properly belongs to the Bryle or loofe fhattery back of a Lode, when it is very rich for Tin or Copper, immediately to the day or furface. Inftances of Bunnys of Ore are very rare with us. We have heard of fuch among the Tin Mines in St. Juft, near the Land's End; and that there are feveral fuch chafms, impregnated with Copper or Lead, in Wales and the north of England, where they are called Pipes of Ore. In the latter we have been informed of a Pipe of Copper Ore, called Eaton Mine, which is two hundred fathoms deep, the Sough or Adit being one hundred fathoms below the furface. When thofe Pipes are exhaufted, if they find water come in upon them, they work to meet it, without regarding what point of the compafs it flows from; and this oftentimes leads them to another Pipe or Bunny of Ore. Likewife, if a few Stones of Tin are found difperfed in our foft Grouan Stratum, by properly remarking the tendency of thefe Stones, and where the heavieft part of them points, it may be nearly gueffed how far off another little Pipe or Bunny of Ore may be; or, at leaft, they will bring you to what is more natural, a true Lode, as we every day experience in our difcoveries of Tin Lodes by Shodeing, as will be hereafter defcribed.

After all; the Fiſſures which are common to us, are the perpendicular, and the inclined, let their direction be either north and ſouth, or eaſt and weſt. Be they impregnated with Metal, or quite barren and void of Ore, they are uſually ſuch as we have above deſcribed; and when any Floor, Pipe, or Bunny of Ore is met with, we look upon it as a very uncommon diſpoſition of Metals in Cornwall.

Perpendicular and horizontal Fiſſures, probably remain little altered from their firſt poſition, when they were originally formed at the induration of Strata immediately after the waters deſerted the land. Reſpecting the former, we find them more commonly ſituate in level ground, and at a diſtance from hills, or the ſea ſhore, where the Strata might make leſs reſiſtance to ſecondary accidents. But with regard to the latter, we find that the upper and under maſſes of Strata, are different in their ſolidity, and other properties; whence their formation, purſuant to their diſtinct and natural efforts to join each with its like, and to ſeparate from thoſe which are unlike. Hence it is very apparent to us, that inclined Fiſſures owe their deflection or underlie, to ſome ſecondary cauſe, violence, or ſubſidence of the earth: for though perpendicular Fiſſures are ſeldom ſeen, yet the inclined at a very conſiderable depth become more downright, the central Strata being not ſo liable to be wreſted from their primary poſition, as thoſe more near to the ſurface, on the ſides of hills, and the cliffs of the ſea ſhore, of vallies, and of rivers. It is more than probable, that ſundry and diverſe agitations and ſubſidencies have been effected ſince the creation, nay even in our own time and knowledge; which could not but influence, in various degrees, all the adjoining Strata, and their Fiſſures or Lodes.

Fiſſures are not only inclined but fractured; which fracture muſt have been the effect of violence. The inclination alſo muſt have been the effect of force, though, in many inſtances, that force only bent, and did not proceed to that degree of violence, as to break it ſhort off, but only to occaſion what we call the underlie of the Lode. Now if we can diſcover the probable cauſe of the inclination or underlie of Fiſſures, the ſame cauſe, allowing it but a greater impetus, will account for that fracture which we call a ſlide or a heave.

Betwixt the underlie of Fiſſures, and the dippings of the adjoining Strata, there is oftentimes ſo manifeſt an agreement and

and correſpondence, that whatever occaſioned the latter could not but produce the former. Let us firſt note the dippings of the Strata; for if they have alſo been wreſted, their Fiſſures, or the Lodes contained in them, could not have preſerved their ſtation. The original poſition of Strata muſt have been horizontal or parallel to the ſurface of the earth; but we often find thoſe Strata very ſenſibly declined from that firſt poſition; nay ſometimes quite reverſed and changed into perpendicular. When we ſee a wall lean, we immediately conclude that the foundation has given way, according to the angles which the wall makes with the horizon; and when we find the like declination in Strata, I ſhould think we may conclude, by parity of reaſon, that there has been a like failure of what ſupported them, in proportion to that declination; or that whatever made the Strata to fall ſo much awry, muſt alſo cauſe every thing included in thoſe Strata to fall proportionably. Wherever the greateſt ſubſidence is to the north, the top of the Lode or Fiſſure will point to the north, and in conſequence underlie to the ſouth; and vice verſa; the ſlide or heave of the Lode manifeſts the greater ſubſidence of the Strata, but the ſame Lode is frequently fractured and heaved in ſeveral places: all of which, by due obſervation, will ſhew us, they were occaſioned by ſo many ſeveral ſucceſſive ſhocks or ſubſidencies; and that the Strata were not unfooted, ſhaken, or brought to fall once only, or twice, but ſeveral times. (For uncommon ſubſidencies of the earth, ſee Philos. Tranſact. 337. 349. and 405.)

The cauſe of the underlie, interruption, or fracture of our Lodes or Fiſſures, being given, it remains to account in ſome meaſure for the cauſe of thoſe ſubſidencies, which is the efficient Ariſtotelian "id unde," from which the others originate.

When the Almighty Architect, in his infinite wiſdom, foreſaw the neceſſity and uſefulneſs of mountains and vallies, he ſuffered the more lax and weaker Strata to ſink into the abyſs, either totally as in the depths of the ocean, or partially as in coombs, dales, and vallies; and the more compact and ſtony Strata were left to form the mountains and hilly parts of the land. It muſt neceſſarily follow that when thoſe ſubſidencies happened, the adjunct Strata muſt have been proportionably affected, and likewiſe their Fiſſures; hence ſo manifeſt a relation in the Strata and their Lodes in many places, to theſe firſt and principal depreſſions.

The

The encroachments of the ſea from time to time, by its fluctuating pervading ebb and flow, hath ſearched out, and carried off many of the laxer ſubſtances between the Strata; nay it hath even, by its own force and violence, deſtroyed large portions of ſolid rocks and cliffs, which is well known by every perſon acquainted with the ſea ſhore: theſe, together with the larger ſubmarine gulphs or ſwallets, cannot but influence the maritime Strata, and produce ſecondary ſubſidencies of the earth; to which we may aſcribe thoſe contrary and irregular underlies of Fiſſures with us, who are ſo narrowly ſituated between the two channels, and whoſe Lodes are remarkably diſtorted thereby in the pariſh of St. Agnes, and elſewhere on the ſea coaſts.

One more effective cauſe of the diſlocation of Lodes, is that of the general deluge; which deluge, in the pariſh before mentioned, is evidenced not only in the multiform fractures and interruptions of the Lodes, but in the diſtinct and ſolitary mountain, called St. Agnes Beacon, in the proper Britiſh dialect, Carne Bury-anacht, or Bury-anack, the Still Spar-ſtone Grave; where, ſuitable to the name, on the natural remote eminencies thereof are raiſed three Quartz-ſtone Tumuli. The natural circumſtances of this mountain are worthy the conſideration of a philoſopher: for though it is a very high mountain, abutting on the Iriſh ſea or St. George's channel, and riſing pyramidally from the ſame at leaſt five hundred and forty feet above the ſea, yet on the top thereof, under thoſe Tumuli, is diſcovered by the Tinners five feet deep good arable land or earth; under that, for ſix feet deep more, is a fine ſort of white and yellow clay, of which tobacco pipes have been made; and beneath this clay is a Stratum, or layer of ſea ſand, and ſmooth beach pebbles. Two or three hundred fathoms from the ſea, and about eighty fathoms above it, under this ſand, is to be ſeen for five feet deep nothing but ſuch beach Stones, as are uſually waſhed on the ſea ſhore, and in many of them grains of Tin: under thoſe Stones, the ſoil or matter of the earth for ſix feet deep; and under that appears again the firm rock, through which Tin Lodes have been wrought at fifty, ſixty, or ſeventy fathoms deep.

It would be needleſs and impertinent to enter here upon a diſquiſition into the univerſality of the deluge, and the natural means the Almighty uſed to produce ſo unparalleled an event: the greateſt naturaliſts and philoſophers have given different

and

and contradictory folutions of it. I beg leave, however, to obferve, that we are fupplied with innumerable evidences of this grand phenomenon; and notwithftanding we have no exuviæ of land or fea animals buried in our Strata, yet this mountain, of which we have juft fpoken and given the particular circumftances of its fite and contents, is at once a production and an irrefragable proof of Noah's flood.

It is agreed by moft naturalifts, that fome parts of the prefent dry land were, before the flood, part of the ocean's bed; among which, I fuppofe, the top of this mountain was placed, till the Almighty caufe moved upon the furface of the waters, and directed the bottom of the fea to inflate and elevate the mountains of the deep, and thereby diffufe its waters, and level the furface of this earth. But when the vengeance of Omnipotence was finifhed, he commanded the fea and the waters to retire into their former refervoir; whereby the land appeared again, though not uniformly the fame as it was before; neither was it neceffary it fhould be fo, fo long as it was fufficient for all the purpofes of life. At the fame time, the Father of Mercies left thofe remains of his power and juftice, to convince us by nature, as well as revelation, that he is able to do all things.

If we may have credit for this hypothefis, we are to believe alfo, that fome parts of the elevated deep returned to their firft ftations, and that others remained and became the prefent dry land, which was before the bottom of the fea; whereby we prefume to account for the appearances under the furface of St. Agnes beacon, and thofe diftortions of the Strata, &c. in our parts, fome inclining one way, fome another, and fome quite reverfed. Neither will this elevation of the deep, and concomitant fubfidence of the land, appear unnatural to our idea of the matter, when we confider that the loftieft mountain upon the face of the earth, is not quite four miles in perpendicular height, which in fact amounts not to one fix thoufandth part of its circumference; and bears not fo great a proportion to the bulk of the earth itfelf, as the little rifings on the coat of an orange bear to the bignefs of that fruit.

There can be no doubt, that many alterations have happened to various parts of the earth, before, at, and after the flood, from inundations, earthquakes, and the diffolvent powers of fubterranean fire, and water; which variety of caufes and circumftances muft infallibly have produced many irregularities in the diſpoſition and ſituation of circumjacent Strata and Lodes.

Having, as ſuccinctly and clearly as I am able, delivered my own and other people's opinion upon theſe matters, I ſhall, in the next place, proceed to examine the contents of thoſe Fiſſures and their properties; wherein a local and peculiar natural hiſtory will be ſo evident, that I ſhall hold myſelf excuſable to ſyſtematick naturaliſts, if I appear to them irregular and immethodical in the manner which I ſhall take to purſue my ſubject. As I have alſo ſhewn the cauſe, nature, and variations of the Fiſſure, I ſhall in future make little uſe of that term; but in compliance with the cuſtom of my country, ſhall indiſcriminately call a Fiſſure, or its contents, the Lode: for inſtance, when I come particularly to define and deſcribe the interruption and diſorders of Lodes, I ſhall ſay that this or that Lode is heaved to the right, or to the left, up or down, by a croſs Lode, a Contra, a Goſſan, a Slide, a Flookan, or the like, purſuant to the idiom of our Miners; without taking notice of the Strata, upon which ſuch alterations of Fiſſures and their veiny ſubſtances depend.

We have ventured to advance the foregoing hypotheſis, as the moſt likely to account for thoſe appearances which occur in the bowels of the earth; and we are not ſingular in it, but are ſupported by the concurrent opinion of ſome very approved writers upon part of the ſame ſubject. And though we are ſenſible that ſome objections may be ſtarted againſt it; yet we can ſcarcely think, that thoſe who may be moſt forward to deny it, are ſupplied with one that will more rationally point out the cauſes of theſe appearances we ſpeak of. As, however, we do not inſiſt upon the infallibility of our ſentiments, we ſhall ſubmit them to the naturaliſt and philoſopher with the greateſt deference; and ſhall be extremely glad to find, in our own day, the errors of our theory rectified by ſome abler pen.

CHAP.

CHAP. II.

Of the different kinds of Lodes in respect of the Earth and Stones they contain.

THE contents of our Fiſſures are very complicated, and obtain their ſeveral diſtinct appellations from the nature and appearance of the moſt predominant Earth, Clay, Stone, or Mineral, contained in them; without any reſpect to the metallick impregnations of Tin, Copper, or Lead, unleſs the Ores of thoſe Metals are very rich, and more abundant, than all the other contents of their Fiſſures. The ſame Lode, at higher or inferior levels, ſhall be alternately named a Goſſan, Mundick, or Flookany Lode, purſuant to their predominancy at twenty, forty, or ſixty fathoms depth; or any other intermediate level they may offer to the obſervation of the Miners. Upon this account, moſt Lodes take their names from the kind of Stone or Mineral they moſt abound with, which often participates very largely of the nature of the Strata encloſing them.

The generality of our Lodes are very different to the eye and in their impregnation, near the ſurface, from what we find them when deeply ſunk upon; and though it has been known, that the backs of ſome few veins have proved very rich, yet they do not always hold Metal, and frequently they do not carry Tin or Copper Ore enough to pay the charge of dreſſing or cleanſing them: nevertheleſs, in the ſinking upon ſuch veins, we hope they will depart from their primary colour and appearance, and form large bodies of Tin or Copper Ore.

The ſlight metallick impregnations of our Lodes, which, eſpecially in Copper, are generally obſerved to fifteen, and even thirty fathoms deep, muſt certainly ariſe from the ſcarcity of ſaline mineralick principles, which the water ſo near the ſurface cannot be largely ſaturated with; and having leſs depth of Strata to receive the metallick ſolutions from, they of neceſſity cannot be furniſhed with ſtrong menſtrua, to act upon the Lodes, or depoſite themſelves. Although Mines are ſeldom diſcovered rich upon the backs, we preſume for the reaſons before given; yet experience will inform us, that they are ſometimes well ſtored with Copper and Tin Ores of the richeſt quality near the day

day or ſurface ; but this more frequent in the latter, though of no long continuance.

We ſhall divide Lodes which carry Tin, Copper, and Lead, into twelve different kinds, in regard to their foreign Materials; and the removes viſible in them, we ſhall claſs into their proper ſubdiviſions. The Lodes are ranged in the following order :

I.	A Goſſan Lode.	VII.	A Cryſtal Lode.
II.	A Peach Lode.	VIII.	A Killas Lode.
III.	A Scovan Lode.	IX.	A Mundick Lode.
IV.	A Caple Lode.	X.	A Black-Jack Lode.
V.	A Pryan Lode.	XI.	A Flookan Lode.
VI.	A Quartz Lode.	XII.	A Grouan Lode.

I. Of all theſe Lodes, the Goſſan is moſt common ; and is ever diſpoſed to yield Tin and Copper, if it runs eaſt and weſt ; but thoſe of a contrary direction, in reſpect of thoſe Metals, are ſteril and worthleſs. Goſſan may not improperly be divided into five ſorts : viz. 1. a Tender Red Goſſan ; 2. a Tender Brown Goſſan ; 3. a Dry Pale Yellow Goſſan ; 4. a Poor Tin Goſſan ; and 5. a Gal or Gally Goſſan : all of which are och-reiſh ſubſtances, of a ruſty ferruginous complexion, being moſtly Earth and Cryſtal coloured by Iron, with frequently no incon-ſiderable portion of that Metal.

1. The Tender Red Goſſan is very much inclined to produce Copper Ore, eſpecially if the Goſſan be ſpungy, cellular, and of a very red colour, like to a well burnt brick. When it is thus, and ſpotted, or tinctured with green Copper Ore, like pieces of Verdigreaſe, it does not often deceive the proprietors. So, likewiſe, Stones of blue or black Copper Ore, or of yellow Ore having a black or purple outſide, are very hopeful to follow when mixed in this Goſſan. Yet the Ore in this nidus is bunchy and uncertain, till proved to ſome tolerable depth. But if Stones of Lead Ore be found in this Goſſan, it promiſes well to produce a good quantity of Lead. This kind of Goſſan was upon the back of Pednandrea Lode, and ſome parts of Huel Sparnon, and is now very plentifully to be riſen at Michell's Goſſan Mine, in Redruth.

2. A tender Brown Goſſan, much of the colour of Iron, very brittle, and full of holes. The ſmaller particles of it are of a browniſh yellow, very crumbling, and fall to duſt by long expoſure

expofure to the air. It is this Goffan which backs the Huel Virgins in Gwenap.

3. A Pale Yellow Dry Goffan, of a hard cryftalline intermixture. This fort of Goffan fometimes yields Copper Ore, yet feldom turns to any great account. However, I believe it to be more promifing for Lead than Tin or Copper, as I have obferved it to produce that Metal in Nanfkuke Downs and elfewhere. This muft be moft like the Goffan of Hernn Groundt Copper Mine in Hungary, the mother of which Ore is yellow, fays Dr. Brown, Philos. Tranf. 59.

4. A Poor Tin Goffan, implies that which is fo in refpect of its yielding Tin; for otherwife, it may be kindly enough for Copper. This Goffan fometimes will yield a very tolerable profit, on account of its cheap and fpeedy working for Tin. If it is red and brittle, it is a good indication of Copper Ore in depth, as the Tin leffens and wears out; and if it is tinctured with Verdigreafe, it is very hopeful indeed. Formerly, a notion prevailed, that every Goffan which did not produce Tin upon the backs, was not worth the attention of the concerned for Copper; but it was a vulgar error derived from father to fon, in times when Copper was very little known. Huel Virgin, and other great Copper Mines, have proved, that Goffans not productive of Tin, will yield abundance of Copper.

5. A Gal, (Kal) or Gally Goffan, is of a hard compact nature; its colour blacker than the other Goffans, and more like rufty black Iron. This makes Tin; but it very feldom anfwers for Copper, unlefs it changes to tender and brittle. This Goffan contains fo much Iron, that it fometimes ought to be ranked as an Ore of that Metal: I have been informed by my friend Mr. Bennallack, that he has affayed fome Stones of this Gal, which have produced three-fifths of their weight, good Iron; but this is feldom found in confiderable quantities, and its different Lodes are impregnated therewith, from this large to an exceeding fmall proportion.

Though all thefe Goffans have an intermixture of each fort, yet that which is moft abundant, gives the Lode its denomination. A tincture like Verdigreafe is not to be rejected in any of them, for it is very promifing for Copper.

II. A Peach or Peachy Lode, takes its name from a kind of Stone which principally abounds in the Lode, and is generally of a ſpungy texture, and of a greeniſh or dark green olive colour. It is better for Tin than Copper; but is not a deſirable Lode for either, eſpecially the latter, which is always of a poor quality and value when found in a Peachy Lode.

III. A Scovan Lode, is formed of a hard compact cryſtalline Stone, either of a brown or black hue, according to the colour of the Tin with which it is mixed. The Ore is often rich, ponderous, and ſolid in this Stone; and when it is worth one half for Metal, they call it Scove. The Lode is uſually very ſmall, from the breadth of four inches to fourteen; the latter is thought to be a tolerable ſize; and, notwithſtanding its ſolidity and demand for gunpowder to blaſt it, will yield much profit to the adventurers under other favourable circumſtances. Sometimes this Scovan Tin lies in a leſs ſolid Lode, as to the Lode itſelf, which is cavernous, and full of holes, thence called a Sucked Stone by the Tinners, as if all the heterogeneous matter had been ſucked or rather waſhed out of the Stone, and nothing was left behind but pure ſolid Tin Ore. This ſucked Scovan Lode is larger when it occurs, even to ſome feet in breadth; and ſo is the ſolid Lode likewiſe at times.

IV. A Caple Lode. The Scovan Lode, when in decay for Tin, will commonly degenerate into a Caple; which, in fact, is moſtly of the nature of a Scovan Lode's walls, or that encloſing Stratum, which it is in contact with; thence called the Caples, or walls of the Lode. But there is really ſuch a thing as an original Caple Lode, properly ſo called; which abounds with a very ſtiff hard Stone, ſomething like a Limeſtone, except the colour; wherein the Tin is ſometimes veined, and other times very ſmall and diſſeminate. A primary Caple Lode is promiſing for Tin, though but ſeldom ſo for Copper; unleſs there is a branch of Copper Ore or Goſſan, that runs downwards in the Lode: if this Caple chances to hit into a body of Copper Ore, it commonly makes a durable Mine though the Ore is none of the richeſt.

V. A Pryan Lode, is ſo named, not in reſpect of any peculiar quality of the Earth or Stone, any further than barely that it lies in the vein, in an arenaceous pebbly ſtate, with ſmall Stones of Ore intermixed, and not in large rocks or Stones; in which ſenſe, a Goſſan, Flookan, Mundick, or any other Lode,

may

may be called a Pryan Lode. This fort of Lode is very tender, and apt to yield Tin of the pureft metallick quality. The Lode is often fo very lax and fandy, that it will run againft the workmen like a fand bank ; and the man who handles his fhovel beft, is preferable to a Pick-man. If the walls of the Lode are tender likewife, it requires much timber to bind and keep open the workings. When Copper Ore is Pryany, it comes to grafs very cheap and fpeedily, and produces a quick profit.

VI. A Quartz Lode, or Rampant Spar Lode, vulgarly fo called, is placed by fome among the Goffans, though I do not fee for what reafon ; this being a hard unmetallick petrifaction, thence called a Spar Lode by thofe unacquainted with real Spar. There is no Lode totally exempt from this Stone ; and many branchy veins of it are to be feen throughout all our ftrata, unmixed with any other matter. In the grofs here fpoken of, it is a hard, opaque, yellow, or white cryftalline exudation, from the adjoining Cryftal rock.

VII. A Cryftal Lode. Quartz is undoubtedly the moft debafed kind of Cryftal ; yet with regard to Cryftal Lodes, I can from experimental knowledge make four other diftinctions, whereby their good or evil tendency for Tin or Copper, will more evidently appear.

1. The firft is a greyifh white, dull, hard, opaque, and rocky Cryftal, which produces no Metal in itfelf, or in thofe Lodes which degenerate into its kind ; for even if there are fome Stones of Ore found in other Lodes, yet where this comes in, it is a certain prognoftick of fterility and decay. It is moft natural to Tin Lodes at a great depth.

2. A fmutty black, or black grey Cryftal, is a very unlikely appearance for Copper Ore. It occurs but feldom ; and when it does, it betokens a very fudden decay, though the Lode was fruitful before.

3. A brown candied, or amber coloured Cryftal. This is fmall, tender, and very like brown fugar candy. I take it to be hopeful for Copper ; and it moftly abounds with a black Pryany Copper Ore, which laft confiftence it imparts from its arenaceous property. This wears out in finking, and the Lode generally changes to a yellow Ore, and folid Stone.

4. A white candied, or pellucid Cryftal, commonly termed a White Sugar Candy (Spar) Cryftal. This, if it is mixed with Goffan and Stones of Copper Ore, is very likely to abound with great quantities of Ore, but the Cryftal muft be very tender, lax, and fandy. Alfo if it is clear, or tinged with green or purple, it is very promifing for Copper; and difappoints the patience and purfuit of the adventurers, as feldom as any Lode.

All thefe Cryftal intermixtures, are very often found in different parts of the fame Lode; and the nature and qualities of the Lode vary accordingly. The two latter are moftly in Copper Lodes, and feem to be more particularly the Cryftal Septa of Goffan Stones in a broken fhattered ftate, by the difcharge of its Mineral Earth or Ochre.

VIII. A Killas Lode. All Lodes, except this, derive their names from the coat they wear upon their backs; at leaft their firft names are given in confequence of their firft difcovery: but in this before us, the cafe is otherwife; whence fome may object to the name of this Lode adopted by the writer; but they may as well demur to the received name of a Grouan Lode, or any other which participates of the environing ftratum. Goffan and Scovan Lodes, which are rich upon the backs, in depth come (though very rarely) into the nature and qualities of the enclofing ftratum of Killas. The red Killas bears Tin; but it is dry, barren, and ferruginous: the brown is common with Tin, and is hard and Capley: blue Killas, in depth, is fometimes blended with Copper Ore by the cementing medium of white Cryftal. If the Killas is tender, fat, and fleaky, it is fpeedily wrought, and agrees well with its united Ore; but if it becomes exceeding hard and ftubborn, the Ore is impoverifhed and chargeable to break. I fpeak of this Lode as a Rara Avis, and merely adventitious.

IX. A Mundick Lode. Some Lodes are moftly compofed of rank Mundick near the furface, and too often continue fo in depth; but there are inftances, of their being richly blended with Tin and Copper in further finking. "The Pyrites (Mun-"dick) proves a fure guide to Lead and Copper Ores, which "with us are not eafily feparable; feeing they generally lie fo "mixed together, or fo near each other, in one and the fame "view, that it appears almoft impoffible for the one to be "without the other: and, indeed, it is no eafy matter to "find a vein in the earth, in what direction, and to what

"depth

" depth fo ever it runs, unaccompanied with Pyrites (Mun-" dick)." (Henckell).

In cafe the Mundick affociates with a rotten, black, ferruginous earth, which contains Stones of Copper Ore, it bids fair for an agreeable alteration. By finking in a bed of Mundick, or driving through it on the courfe of a Lode, it may probably alter and come into Copper Ore. On the contrary, if a Mundick Lode continue hard and inflexible, it portends no good. Tin or Copper Lodes, that change their metallick impregnations for Mundick, and hardnefs, are better deferted han followed.

X. A Black-jack or Mock-lead Lode. This is very fhallow and rich both in its nature and appearance. It is compofed of flakey, tabulated, polifhed, fhining, fatty, black earthy Stones; and, like many other Minerals, is moft rich, in proportion as it is lefs hard. This is one of the Zinc Ores, and it has been ufed in fome quantites inftead of Calaminaris; but it is fo corrupted by a certain admixture of Iron, that it holds an inconfiderable eftimation among the workers in Brafs. This Wild-lead is commonly found with Stones of Copper and Lead intermixed with it; but it feldom or never has any Tin. If it affumes a hard nature in depth, and breaks off in great jointed rocks, it is a bad fign for Copper Ore; and that which is got in this fort of Lode, is never very rich in quality. We have been affured by fome who are converfant with affaying Copper Ore, that where the Ore has been much corrupted with this Black-jack, their affays had the appearance of and undoubtedly were a very coarfe Brafs.

XI. The Flookan Lode takes its name from that tenacious glutinous Earth or Clay, that fometimes runs without fide fome veins, immediately between either wall of the Lode and the Lode itfelf, and more frequently I believe adherent to the hanging or fuperior wall. At other times it is intimately mixed in and throughout the Lode itfelf; and if the vein exceeds eighteen inches in breadth, it is very troublefome to keep from running againft the workmen, and takes much timber to fecure the backs, ends, or other parts of the Mine, which they chufe to leave unwrought. It is generally of a bluifh or whitifh colour, or elfe fhaded between both of a clouded cerulean caft. If Stones or Pebbles of Ore be found in a vein of Flookan, it is

 very

very likely to make either Tin or Copper Ore in depth; and the latter in moſt abundance, if there is a Goſſan branch or leader.

This Flookan or clay-matter in its barren unmetallick ſtate, is ſeldom abſent from a croſs courſe or croſs Goſſan, either adjoining to one wall of the courſe, or like a pith in the center thereof; and is the preventive whereby the water from the eaſt or weſt of it cannot circulate from the true Lode through the croſs Goſſan. Flookany Goſſan Lodes running eaſt and weſt parallel to Scovan or Tin Lodes, if they meet in oppoſition to each other upon the hade or underlie, will ſever at the angle of incidence, and will heave ſuch Tin Lodes higher up; by which means ſometimes a deep work has become as it were renovated, ſo as to make a new back and new work. But of this in its proper place.

XII. The Grouan Lode abounds with a kind of rocky Stone of that name, either caſually very ſoft and tender, or very hard and invincible to pick and gad, unleſs firſt blaſted by gunpowder: where Lodes do abound with this Stone, it is always in a ſtratum of its own kind, uſually called a Grouan or Moorſtone-country. It is an aggregation of coarſe, angular, arenaceous Pebbles, or fragments of Quartz and Cockle, cemented together by a cryſtalline juice, and variegated with ſmall ſcales of black or ſilver ſhining Talck. When Tin Ore happens in theſe Lodes, it is always good in quality; but they ſeldom miſs of deceiving thoſe who ſeek for Copper or Lead: and when a Goſſan Lode happens in a Grouan ſtratum or country, it is not ſo inducing to adventure in, as when it happens in a Killas country; but that it is totally unpromiſing for Copper Ore, the Mine of Treſavean will contradict.

We again remark, that what we have ſaid above on the different ſorts of Lodes, is moſtly on a ſuppoſition of their being diſcovered ſhallow; and alſo, that they frequently change and vary, both in depth and alſo on the courſe of the Lode; ſo that in order to make a ſatisfactory trial of a vein, the Miners muſt "ſpend ground," in other words, they muſt ſink down, and alſo drive on the courſe of the Lode, before they can form a right judgment, whether it may prove ſucceſsful or not: and though a prudent caution forbids every thinking perſon to engage improvidently and deeply in a Mine which has diſcouraging ſymptoms; yet, on the other hand, it is often ſeen, that on trying

trying of Lodes, they alter in their nature and properties very much: however, while a Mine carries a bad appearance, it merits but little regard and attention. All the dry hard Goſſans, the Peach, the Pryan, the Caple, the Scovan, the Mundick, and the Grouan Lodes, are liable to yield Tin; and the tender Goſſan, the tender Cryſtal, Killas, Mundick, Mock-lead, and Flookan Lodes, are diſpoſed for Lead or Copper Ore; eſpecially if they produce Stones of their own proper quality and nature, or are tinctured with Vitriol. Experience ſhews, that the hardneſs of a vein or Lode near the ſurface, always denotes no good diſpoſition for Copper or Lead; nor is it always a good ſign, to meet with Copper Ore at a ſhallow depth: but as to Tin the caſe is oppoſite; for it is often found rich in a hard Lode, and at a ſmall depth, the richeſt Tin Lodes we have being in a very hard Stone; yet a tender Lode often produces Tin as well as Copper; and, upon the whole, I would prefer a tender Lode for both.

Stones of Ores or Metals, have their ſinuſes or joints, the ſame as common quarry Stones; and thoſe ſinuſes often facilitate the breaking and working of the Ore, becauſe the labourers are thereby at greater liberty to drive their gads or iron wedges into ſuch joints or diviſions, in order to break the ſolid rocks of Ore. When a Lode breaks away in large jointed rocks, be it of what kind ſoever, it implies no good for Copper or Lead; however, if it chances to alter and prove better for either, it generally makes a laſting Mine: ſometimes it ſo falls out, that as a tender Lode comes into Ore in depth, it proves ſo hard, that they are often obliged to bore holes in it, and blow it with gunpowder; and yet the Mine ſhall be very rich, laſting, and profitable.

We muſt not omit ſome particular ſorts of Stones, which are often met with in Lodes, though the veins are not called by their names; becauſe the Stones do not continue, except for a ſhort length, and ſmall depth. There are alſo ſome other Stones which are very troubleſome to the labourers, and very chargeable to the adventurers.

Among theſe the Elvan Stone is very common; which is a ſandy gritty Stone, moſtly very hard, and of a pale yellow, or whitiſh grey colour. When it is found in a Lode, it forebodes no good ſucceſs in that part where it lies; for, as far as it continues, it is ſaid to ſtarve the Lode with reſpect to Copper or or Lead, although ſometimes it does not prove very hurtful to Tin. Another ſort of Stone is often met with in Lodes, which they call a Lîver Stone, or Lîvery Stone, from its uſual liver colour. This is generally very hard, and apt to impoveriſh the Lode; but when the Miners work a little further or deeper, they commonly come to an alteration of ground, and then the bad effect of theſe Stones alters likewiſe.

It frequently happens in very large and alſo rich Lodes, that when they dig a great depth in them, there appears a kind of Stone about the middle of the vein, of the ſame nature of the ground or ſtratum nigh the Lode, being not at all of a veiny quality, though it is in the body of the Lode. This is moſtly of the Killas kind, it being the common ſtratum at a great depth. It will firſt be diſcovered, perhaps, in the middle of a vein; and will ſpread as you ſink upon it, like the back of a horſe pack ſaddle, till it occupies the whole breadth of the Fiſſure, except one or two ſtrings or leaders of Ore on both or either ſide of it. The Corniſh Miners call it a Horſe; and when they meet with it ſay, "The Lode has taken horſe." The continuance of this unwelcome ſtranger, may be for the ſinking or driving of ſeveral fathoms of ground; and it may be thought expedient ſometimes to ſink and drive under it, through it, or at one end of it, and leave the greateſt part ſtanding, which may ſave expence, and be uſeful to keep open the workings, if its footing or ſupport at the bottom is not unſkilfully wrought away by the incautious Miners. Thus, by ſinking and driving, according as place and circumſtance will admit, they recover the Lode again: however, it is always ſuſpected whether the Lode will continue ſo rich and plentiful as before; and it has ſo happened, that the Lode has never recovered its former good quality.

At, or ſoon after the time, when the ſplit, crack, or Fiſſure, in ſuch place happened, a part or ſide of the Fiſſure being more lax and incompact, ſeparated, fell off, and lodged upon the lower wall of the Fiſſure: which ſeems to me, the only accountable cauſe for the formation of thoſe large Horſes we ſometimes ſee in Lodes; and in ſupport of my opinion, I remark, that the contents or ſubſtance of a Horſe, is leſs hard than the Stratum from which it was ſeparated, it being of a ſhattery looſe texture, like a ſlatty Killas. It generally occurs where the Fiſſure is largeſt; and the continuity of the veiny part of the Lode each ſide, further corroborates the idea.

Therefore

Therefore it is no wonder, when injudicious Miners work away the footſtool of a Horſe, that they ſhould pay for their temerity, by the forfeit of their lives ; yet ſuch has been the caſe, and the adventurers have been often put to unneceſſary expence in ſtemples and lock-pieces to ſecure the Mine from falling in.

It is obſervable in driving, or ſtopeing upon the courſe of a Lode, that when it changes from its uſual underlie to nearly perpendicular, and then the lower wall ſtarts off from its common underlie, to that which is contrary, and the Lode or Fiſſure widens pretty much ; in ſuch caſe the Miners expect to meet with what they call a Horſe : but unleſs they come down in ſinking upon the back or top of it, they ſeldom call it by that name ; and when met with in ſtopeing, or driving as aforeſaid, they commonly ſay, " It is a ſtope of dead ground."

CHAP. III.

How Mines are diſorded, interrupted, fractured, elevated, and depreſſed, by the Intervention of Croſs-Goſſans, Flookans, Slides, Contras, &c.

LODES are not interrupted, fractured, heaved, or otherwiſe diſordered, by the intervention of Flookans, Croſs-Goſſans, Slides, or the like : it has ever been the miſtake in this caſe, to ſubſtitute the effect for the cauſe. I have already ſhewn, that the fracture and heave of a Lode, is produced by a ſubſidence of the ſtrata, from their primary poſitions ; ſo that what we call a heave, is a falſe term, and altogether contrary to the idea I conceive of the matter ; for, inſtead thereof, it is a ſinking of the ſtrata, and ipſo facto occaſions a depreſſion, ſubſidence, or ſinking of a Lode, inſtead of an elevation or heave. Nevertheleſs, in compliance with the phraſeology of our Miners, I am obliged to uſe that dialect which is commonly known and received among us. It will be difficult, nay almoſt impoſſible, to perſuade thirty thouſand illiterate perſons, that their notions are wrong, and their expreſſions inaccurate. I muſt, therefore, proceed in the uſual ſtyle of the Tinners, and write as they converſe upon thoſe ſubjects.

We have already obferved, that our veins generally run eaft and weft; but this muft be underftood of the metallick veins; for there are fome, which run quite acrofs them, that is, north and fouth, or obliquely fo, with fome fmall deviations from thofe cardinal points: thefe are called Crofs-Lodes, Crofs-Courfes, Crofs-Flookans, Crofs-Goffans, and Contras or Caunters. They are generally quite barren for Tin or Copper; but we have fome few inftances of Crofs-Goffans being wrought for Lead, though not to any great profit. Some antimonial veins run alfo north and fouth.

The Crofs-Goffan runs ftraight on, without any interruption from other Lodes; for it feems to be irrefiftible in its ftretch through the earth, breaking through and interfecting all metallick veins it meets with, feparating and throwing afide the correfpondent ends of thofe veins from each other, perhaps twelve inches or twenty fathoms. The underlie of thofe Crofs-Goffans are either eaft or weft, little or much, like other veins. Thefe Crofs-Lodes are not without their ufe; for in bringing home adits, they afford an eafier paffage, than perhaps the folid ftrata would have permitted, efpecially if a ftratum of Ire-ftone lies in the way: furthermore, by carrying one of the walls of the Crofs-Courfe in the level or adit, you are almoft certain of cutting all metallick veins in your way to the Mine.

When the Miners are working upon a metallick Lode, and are driving from eaft to weft, or from weft to eaft, they often meet with a Crofs-Goffan, which, as before obferved, unheads and breaks off the continuity of the Lode they work upon, by running acrofs through it and caufing a fchifm or rent; fo that if they work ever fo far in the fame line or direction through the Crofs-Courfe, they never will meet with the loft vein, becaufe its correfponding part is removed from its true fite and pofition by the intervention of the Crofs-Courfe which throws it off further north or fouth. The Crofs-Goffan interfects the Lode fometimes at right angles, and fometimes obliquely, and diforders it more or lefs in proportion to the bignefs of the Crofs-Goffan, and alfo of the underlie both of that and of the true courfe; and it is often fo very intricate, that the moft expert Miners are at a lofs to find and difcover the fevered part of the true vein.

If the metallick Lode is intercepted at right angles, it is moved to the right hand a very little way, perhaps not more than

than one fathom, as in figure 2. plate 1. Thus, if they are working or driving from eaſt to weſt, or contrary from weſt to eaſt, and perceive the Lode is gone and the Croſs-Courſe fully apparent, then they cut through the Croſs-Courſe, and ſo turn houſe as they call it, or, in other words, they drive north or ſouth, making a right angle almoſt with their former drift or working on the metallick Lode; and thus they work till they find the loſt or adverſe part again, or till they think they are gone too far, and that the Lode is thrown the other way; then they face about and drive the other way, which ſeldom diſappoints their expectation of cutting the true Lode again. By certain experience this is the only method of diſcovering the metallick Lode, provided it is only removed at the ſame depth in which you loſe it. This will beſt appear by conſidering figure 1. plate 1. Let the Lode E and W repreſent a vein interſected and thrown out of its true plane of direction by the Croſs-Goſſan N S, ſuppoſing the Miners are working from E to W; then, when they come from E to B, they will loſe their Lode, and meet with the Croſs-Courſe; in cutting of which quite through, and then driving to C, they will meet with their metallick Lode afreſh to the right hand. The converſe of this propoſition is eaſily demonſtrated; for if we ſuppoſe they are driving from W to E, then, when they come from W to C, they will loſe the Lode, and meet with the Croſs-Goſſan; but in cutting through it, and ſo driving to B, they will find the metallick Lode again, to the right hand as before.

The pointing alſo of a rib or ſtring of the true Lode, if carefully obſerved, will inform them to which ſide or hand the other part is removed; as will alſo what they call a Scrowl of the true Lode in the Croſs-Goſſan: therefore none but wary cautious Miners ſhould be ſuffered to work in an end or ſtool of Ore, when it is thought to be near a Croſs-Courſe, who by obſerving every ſtring or branch of the metallick Lode, at the place of incidence, may judge which way it is thrown, and ſeek for the loſt part of the Lode accordingly. This interruption by a Croſs-Goſſan at right angles, is moſt common, and attended with leaſt difficulty; but when the interruption happens at oblique angles, the Lode is not eaſily recovered. The general rule, however, ſtands thus; when the Croſs-Courſe runs obliquely N E and S W (north eaſt and ſouth weſt) it moves the metallick Lode to the right hand, as in figure 3. plate 1. on the other ſide of the Croſs-Goſſan; but if it runs very obliquely S E and

N W,

N W, it ſometimes removes to the left hand on the oppoſite ſide of the Croſs-Goſſan, as in figure 4. plate 1.

An explanation of the firſt figure in plate 1, is ſufficient to convey an idea of the horizontal diſorder or interruption of Tin and Copper Lodes, by the intervention of Croſs-Goſſans. The diſorder imputed to real croſs unmetallick Lodes, is ſolely horizontal, either rectangular, or oblique, and the true Lode is never elevated or depreſſed thereby as in Courſe-Flookans or Slides and parallel Lodes of a contrary inclination.

Croſs-Goſſans not only move Lodes out of their places, and true point of direction, but they diſorder them ſometimes ſo as to break and divide them into leſſer ribs or branches ; ſo that Miners often follow the wrong branch to their great detriment and diſappointment : theſe alſo, or rather the hardneſs of the adjoining ground, ſometimes occaſion a deflexion or turning in the Lode, which we call an Elbow, whereby it deviates more or leſs from its true direction.

In the center, or on either of the walls of theſe Croſs-Goſſans, there is always a clayey ſubſtance, called the Flookan of the Courſe, not unlike the pith of vegetables ; which, though it be no more than a finger's breadth, effectually dams up the water from circulating from one part of the metallick Lode, to the other that is ſevered by the Croſs-Courſe ; inſomuch, that the two parts of the ſame vein may be worked to any different depth, without being at all annoyed by the water thus ſeparated by the ſmalleſt Flookan : or however quick the water may be on one ſide, the other may be ſafely worked without fear of interruption from the water of the other ſide ; which is a great advantage in Mining, and therefore, under certain circumſtances in ſome Mines, they are very careful not to penetrate through this natural dam, leſt they loſe their Mine by an inundation of water. We may venture to add our opinion, that we owe many of our fountains and ſprings on the ſurface of the earth, to theſe croſs veins ; for the circulation of the water brought by innumerable ſprings into the larger veins being ſtopt by theſe croſs Lodes, it bubbles up when favoured with a ſuitable ſituation in the ſurface.

Near to a Croſs-Courſe, the true Lode, or the diverged branches thereof, are generally rich for Metal ; becauſe the water, whether impregnated little or much with Mineral or metallick

metallick particles, meeting with an obſtruction at that place, if the nidus is at all diſpoſed for the decompoſition of the ſuſpended Mineral, it will conſequently be depoſited immediately there, by means of its obſtruction, reſt, and continuance in that particular place. In ſome inſtances, however, one part of the Lode may be rich home to the Croſs-Courſe, and its correſponding ſegment poor and barren: the one part will be tender and feeding for Ore, and its adverſe will be hard and unpromiſing.

It would be difficult to conceive, how the broken parts of a vein, which in all probability were once united, ſhould be of ſuch different qualities at the point of interſection, except for the reaſon before given why they ſhould be rich at ſuch places; for it is eaſy to imagine, that water may be ſtrongly or weakly impregnated with mineral particles on either ſide of the obſtruction through which it has no intercourſe, and therefore muſt be differently ſaturated, according as the neighbouring ſtrata by their ſterility or copiouſneſs of mineral principles may improlificate that element. I beg leave to obſerve, that theſe facts, and my theory in conſequence of them, are to me coincident proofs in ſupport of my opinion of the origin of Metals and Minerals.

Becauſe the Croſs-Goſſans, or Croſs-Flookans, run through all veins of oppoſite directions, without the leaſt interruption from them, but, on the contrary, do apparently disjoint, and diſlocate all of them; it ſeems reaſonable to conclude, that the eaſt and weſt veins were antecedent to croſs veins; and that ſome great event, long after the creation, occaſioned thoſe tranſverſe clefts and openings. But how, or when, this ſhould come to paſs, we cannot preſume to form any adequate idea; unleſs the reader will admit the following ſcriptural and philoſophical account of the deluge, as a probable ſolution.

The inſtrumental cauſes of the deluge, were "the broken "fountains of the great deep, and the rain which poured from "the windows of heaven." Now Mr. Whiſton ſhews from ſeveral remarkable coincidencies, that a comet deſcending in the plane of the ecliptick towards its perihelion, paſſed juſt before the earth on the firſt day of the deluge; the conſequences whereof would be, firſt, that this comet, when it came below the moon, would raiſe a prodigious, vaſt, and ſtrong tide, both in the ſmall ſeas, (which, according to his hypotheſis, were in the antediluvian earth, for he allows of no great ocean there, as in ours) and also in the abyss which was under the upper crust of the earth; and that this tide would rise and increase, all the time of the approach of the comet towards the earth. By the force of which tide, as also by the attraction of the comet, he judges, that the abyss must put on an eliptick figure, whose surface being considerably larger than the former spherical one, the outward crust of the earth, incumbent on the abyss, must accommodate itself to that figure, which it could not do while it held solid and conjoined together. He concludes, therefore, that it must of necessity be extended, and at last be broke, cleft, and fissured, by the violence of the said tides and attraction; out of which clefts or fissures, the included waters issuing were a great means of the deluge; this answering to what Moses speaks, of "the fountains of the great deep being broke "up." To remove this vast orb of waters again, he supposes a mighty wind to have arose ("God made a wind to pass over "the earth, and the waters asswaged. The fountains also of "the deep, and the windows of heaven were stopped, and the "waters returned from off the earth continually") which dried up some, and forced the rest into the abyss again, through the clefts or fissures by which it came up; only a large quantity remained in the alveus of the great ocean, &c. He has since proved, that there was actually a comet near the earth at that time, viz. the same great comet which appeared again in 1668. Mr. Whiston, therefore, no longer looked upon what he had advanced as an hypothesis; but has republished it in a particular tract, entitled "The Cause of the Deluge demonstrated."

To whatever active cause we may attribute the completion of so great a phenomenon, we are nevertheless certain from the word of God, and natural observations, distinct from philosophical enquiries, that the waters of the great deep were broken up, the hills in the ocean were elevated, the mountains of the land were sunk, and the earth was variously rent and torn asunder. When those schisms were made, it is probable, the earth was wrung with contortions to the right and to the left, and reeled to and fro like a drunken man, whereby the continuity of veins in the earth were divided and separated to some distance asunder, and eventually caused those chasms and fissures called Cross-Courses; which partly by the return of the waters into the great abyss from whence they came up, were filled with the loose contiguous Earth and Stone within the vortex of the minister of God's vengeance; and partly by the petrifying agglutinating properties that are inherent in waters circulating through

through the bowels of the earth. Indeed it is probable, that the greateſt part of the contents of thoſe contra fiſſures, which are only obvious and proximate to our ſhallow reſearches, are produced by the petrifactive quality of water; for they conſiſt of a large proportion of debaſed Cryſtal, a branch or pith of clay, and a yellow or red ochreous earth, which gives it the name of a Goſſan. The firſt is a petrifaction; the ſecond is the finer parts of the ſtrata ſqueezed out by the compreſſion and reconſolidation of the earth, if I may be allowed the expreſſion; and the laſt, is that ſpume or ochre, which continually oozes through the pores of mineralized ſtrata, as we ſee on the ſides of every drift and adit under-ground.

When two metallick Lodes near each other, do not run parallel in their courſe or line of direction, but make an oblique angle, they muſt neceſſarily meet together; and if they are both rich and inclinable to produce Ore, they commonly yield a body of it at the angle of incidence, or, as the Miners ſay, where the Lodes elbow each other: but if the one Lode is poor, and the other rich, then they are both either enriched or impoveriſhed by their conjunction; and it is uncertain which will happen. After ſome time they will ſtrike off again, and each continue its former direction, diſtinct though near to the other: but there are ſome very few exceptions to this, both continuing ſometimes united.

When the Miners are working along on the courſe of a Lode, ever ſo good, and they find it ſeparate and diverge into branches or ſtrings, it is a great ſign of its poverty, in that place where it is ſo diſordered; but, on the contrary, if they are driving on branches of Ore, and they find them embodying or coming together, as they work on the courſe of the Lode, it is promiſing.

There are alſo branches from another quarter, which inſtead of being within, are without-ſide the walls of the Lode, in the contiguous ſtrata or country. Theſe branches often come into the Lode either tranſverſely or obliquely, into its line of direction. Now, if theſe branches or ſtrings are alive, or impregnated with Ore, and alſo if they underlie faſter than the Lode, then they are ſaid to overtake or come into the Lode, and to feed where they come into it; but if the branches do not underlie faſter than the Lode, then they are ſaid to go off from it, and thereby ſtarve and impoveriſh it: yet it is difficult to conceive a right notion

notion of these kind of branches, without occular demonstra-ſtration; neither are theſe nor any other indications of the fruitfulneſs or ſterility of a Mine, entirely to be depended on; for many Mines which have no good ſymptoms at firſt, do nevertheleſs prove rich; others again, which ſeem exceeding hopeful, alter for the worſe; ſo that there is no certainty how a Mine will anſwer till it is tried in depth: however, as it is not prudent to neglect an adventure of a promiſing aſpect; ſo alſo it is very imprudent to expend much money on a Lode, which wants encouraging marks of making a profitable Mine.

If a man is working downwards in depth in a Mine, then every branch he meets with is ſaid, by the Miners, to be coming into the Lode; on the contrary, if he works upwards towards the ſurface, then every branch he meets with is ſaid to be going off from the Lode: now, this is like taking the ſame thing in two different lights; for at this rate the ſame individual branch may be ſaid to go into or proceed from the Lode, according to the poſition the Miner works in. I think it will be moſt intelligible to the reader, to ſay, that thoſe branches, which come in on the hanging wall of the Lode, are going off from it; and thoſe which come in through the underlying or lower wall, are properly thoſe branches coming into the Lode, enlarging or enriching it with ſuch Ores as the branches contain; and it is very notorious, that Lodes are oftentimes enriched by branches coming into them, of the ſize of an inch in thickneſs, or under.

Lodes are frequently ſo ſqueezed and compreſſed in hard compact ſtrata, that they are not an inch wide; yet if they be alive, that is, if they have a ſolid ſtring or leader of Ore, they often prove well in further purſuit; for by following the rib or leader, they may chance to come into a more tender ground, or leſs compact ſtrata. So if branches or leaders of Ore widen in driving on them, or if they widen in depth, either of theſe is encouraging; but if the branches lie flat or horizontal, and not inclining downwards, they bear no good aſpect. A Mine, however, is not immediately to be given over for a ſmall diſcouragement, becauſe, on ſpending ground, or working on the Lode, it may alter again, and reward the patience of the adventurers.

Small Lodes of Tin but three inches wide, are worth the working, when they are rich, clean, ſolid, and in good feaſible ground. Alſo Copper Ore Lodes of ſix inches breadth, when they

they are ſolid, and are clean from waſte, in fair ground will pay very well for the working. Some of our greateſt Mines have had exceeding large veins; and ſometimes ſeveral very ſmall veins near together, but rich in kind, clean, and in good working ground or ſtrata, conſequently very profitable.

Beſides this natural inoſculation of veins, and their ramifications, we have thoſe which frequently paſs through all others except Croſs-Goſſans, and are called by the name of Contras. Such Lodes direct eaſt and weſt, more nearly than any others; and, therefore, in their courſe run through many other Lodes, interſecting them at very oblique angles. If a Contra-Goſſan impregnated with Copper, meets with its like, they generally make a Gulph of Ore at the place of interſection; but if it takes its courſe through a Scovan Lode, it moſtly damages, impoveriſhes, and diſorders the Scovan.

All veins croſſing each other, may be termed Contras in reſpect of each other, as their courſes are in oppoſition; but from the beſt information I can procure, all thoſe Goſſans which are direct eaſt and weſt, run through every other Lode like Croſs-Goſſans, but do not diſorder them in the ſame manner: therefore, I chuſe to fix the name of Contra, vulgarly called Caunter, to theſe direct eaſt and weſt Lodes, of whoſe direction and fertility the great Huel Virgin is one notable inſtance. It is very obſervable, that almoſt all Goſſans take their courſe through Tin or Scovan Lodes, and from that circumſtance have the names of Maſter Lodes: hence we have abundant reaſon to conclude, that all the fiſſures of Scovan or Tin Lodes were coeval with the creation; and that the fiſſures of Goſſan Lodes, of every ſort and kind, have been formed ſince the creation; and it is apparently ſo from the circumſtances before mentioned, for, the Lode which ſeparates and goes through another, muſt have been formed ſubſequent to that which it divides and paſſes between.

In the next place, I ſhall take notice of Lodes that meet in their underlie; as two Lodes are ſometimes known, in running a parallel courſe eaſt and weſt, to take a direction downwards or underlie towards each other, the one north, the other ſouth, and ſo make conſiderable alterations for the better, or the worſe: for if two neighbouring Lodes do underlie againſt each other, they muſt then meet in depth; and if both are prone to Ore, there are great hopes of a quantity thereof when they meet; but if one be rich, and the other poor, it is uncertain how they will prove at their junction: yet this case seems rather more promising, than when two Lodes meet shallow, for this reason, because the Ore generally happens at some depth; but if they are differently impregnated, that is, if the one is a Tin Lode, and the other a Copper Course, a disorder always ensues, for the Gossan in that case occasions an Elevation, Leap, or Heave of the Tin Lode; but if two Gossans meet thus upon the underlie, they will mutually incorporate and pass through each other, or perhaps strike off from each other, and both take a contrary underlie for some depth, and may be variously rich or poor for Copper, as their niduses may be variously mineralized.

Now if two Lodes are very near together, and underlie both one way, but the hinder Lode more or faster than the other, which seems to go from it; when the case is thus, the hinder Lode will overtake the other in depth, and associate with it. But if two Lodes near each other, underlie alike, and if the hinder one doth not underlie faster than the other, they will never meet, unless they form an angle in their course east in west. By the hinder Lode, I mean that which, by its underlie, follows another underlying Lode; as when two east and west Lodes do underlie north; of consequence the most southern of the two is the hinder one, because it follows the northern on the underlie.

The most considerable disorder which Lodes are liable to in Cornwall or elsewhere, is what is termed a Start, a Leap, or a Heave by a Slide or Course-Flookan. It so happens, that in sinking upon a Tin or Copper Lode, they are suddenly at a loss for the continuation of the Lode downwards. In one day's time, in the working a rich Lode of Tin, they are thus disappointed, and have no further sign of a Lode to work upon; but at the extremity of their working down the Lode in depth, they may perceive a vein of Flookan or clayey-matter, underlying in opposition to the Lode they were sinking upon. This Flookan may be half an inch, or a foot, in thickness; it may be even more or less: but as it is, whenever the Miners are foiled of the Lode they were working, or have lost it in this manner, they conclude and say they are "cut out by a Slide." Now I apprehend the heave is, *cæteris paribus*, in proportion to the size of the Flookan or Slide, which may vary according to the angle of subsidence;

fubfidence; that is, if the fubfidence is great or fmall, fo may the Flookan be more wide or narrow, and the Elevation or Depreffion of the fractured Lode be more or lefs up or down; therefore fome Lodes may be heaved up fome fathoms, and others only fo many feet. Be it little or much, there is an infallible rule whereby they may recover the Lode again, as the reader will readily apprehend by the following fection in the plate.

Tin Lodes are not only heaved by Flookans, called Slides; but they are fo in the very fame manner by oppofite underlying Goffan Lodes, which are fometimes impregnated and fometimes not: but thofe heaves are generally more diftant, and higher up, in proportion to the fize of the Goffan, according to the pofition laid down before. This fracture of the Lode by a Goffan Slide, is what they call, in other parts of England, "A trap up, or a trap down by a ridge;" which, in Somerfetfhire, is defined, "A parting of Clay, Stone, or Rubble;" as if the veins were disjointed and broken by fome violent fhock, fo as to let in Rubble, &c. between them.

As we cannot make the reader readily apprehend this fracture of Lodes, without a reprefentation of it; we have given a tranfverfe fection of Goon Lâz and the Pink Mines in St. Agnes, taken from an actual furvey. Here it appears, that the Tin Lode underlies north, and the Goffan Slide fouth. At the junction of the two Lodes at G, the Tin Lode is cut out by the Slide, and heaved up to H, twenty-two fathoms in perpendicular height, nineteen fathoms horizontally north, and thirty diagonally, by the underlie of the Goffan; fo that if a fhaft had been funk between C and D, no Tin Lode could have been cut or difcovered: but, by the fhaft B, the fame Lode is cut again in the Pink Mine at I, a fmall depth under the adit level, and not very far below the fouth wall of the Goffan. The adit in this place, feems to give the Miners fome direction, how and where to put down their fhaft B: but when the fame Lode was fractured, and heaved again from K to E, their next care was to drive a drift L from K to M, where they cut the Lode again, and rofe upon the back of it up to the north wall of the fecond and fmaller Goffan 2 E; and likewife funk upon their Tin Lode down to N, where it was again fractured by a third and fmaller Goffan 3 O, and heaved about nine feet; cut once more at P, and is now working by virtue of a water engine in the fhaft Q Q, which

which draws the water out of the bottoms of the Mine to the adit, from whence it is difcharged into the fea half a mile off.

The common method for recovery of a Lode, when thus difforded by a Slide or Goffan, is exemplified in the drift L driven from K to M; fo that almoft always, when it is heaved, they drive immediately from the angle of incidence, from the bottom wall of the Slide, be it either north or fouth, until they find the fruftum of their former Lode again: that is, (as in the cafe before us) if the metallick Lode underlies north, the Slide muft underlie fouth, and of confequence the drift for recovery of the loft part muft be north; and fo vice verfa.

In fome cafes they find the Lode again by finking a fhaft from grafs, which anfwers a double intention; for a fhaft muft be had, whenever the Lode is cut by any other method, in order to work the fame effectually: in the Pink, however, if a fhaft had been funk between C and D, or E and F, they never could have cut the Tin Lode again, but in fact would have miffed every remove of it. Again, if they had driven immediately from the place of interfection G, they muft have driven fixty fathoms north, before they could cut the Lode again; which in all likelihood would have been fo tedious and expenfive, that they would have deferted their purfuit before they had driven half the ground, and entirely miffed the intermediate heave K H. Neverthelefs, a difcerning Miner, in either cafe, might find the intermediate heave; for if a fhaft had been funk between C and D, the firft great Goffan I muft have been funk through perhaps at T, and the fame continued down through the next Goffan at V. Thus, by having funk through two Goffans, the experienced Miner concludes the firft heave to be fituated between them, and rifes in the back to cut it, if air and other circumftances are favourable; or, which is better, will fink a fhaft B. The fame propofition holds good in driving; for if a drift is driven from G to V, both the Goffans muft be cut; whence it is eafy to conclude, that there muft be a heave between them. It is very clear, that none but the moft obfervant experienced Miners are proper for this work: incautious injudicious perfons may eafily fink or drive through a Slide, and be totally ignorant of the matter; for they are fometimes not an inch wide, and are fcarcely difcernible; fo that it is a matter of the utmoft nicety, and moft accurate enquiry, to recover a Lode when it is cut out by a Slide, &c.

From

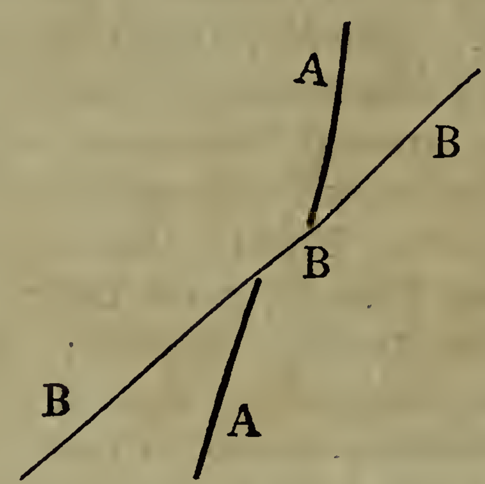
From what has been advanced, thefe corollaries may be drawn: Firft, that all thofe heaves are fractured parts of one and the fame Lode, which were formerly united; efpecially as they confift of the fame kind of Tin, make the fame angle with the horizon, and are all of one breadth. Secondly, that this fractured Lode was formed in the fiffure before it became inclined or fractured in this manner; for G was joined to H, K to E, and N to P. Thirdly, that there muft have been three fucceffive different fubfidencies, to occafion thofe three fractures. Fourthly, that the greateft fubfidence is from C to G; and the Goffan of confequence muft be largeft, on account of the greater rent or feparation there. Fifthly, that the other fubfidencies from E to K, and from P to N, with their Goffans, are, cæteris paribus, proportionally lefs. Sixthly, that thofe Goffans are the effect, and not the caufe of thofe fubfidencies, which are fo reverfely called Heaves; being fo many rents or fiffures filled up in length of time with Clay, Rubble, Ochre, &c. from the contiguous ftrata.

Moreover, it is particularly remarkable, that the furface and ftrata carry many corroborating proofs of fundry fubfidencies at this place; for, at the very fpot, there is a fudden fteep defcent, which forms a narrow deep coomb, or valley. Half a mile further north, I have remarked the fea cliffs, where inftead of the ftrata dipping towards the fea, they are inclined to the fouth, towards the land, and make an angle of nearly forty-five degrees with the horizon. Further off, at a greater diftance in the fea, are two huge rocks, which look like fmall iflands, and are always above water equally high with the main land: whence I have reafon to conclude, that thefe rocks were once a part of the continent; that the coomb was anciently not fo deep as now it is; and that the contiguous ftrata have been unfooted and funk downwards, not only once, or twice, but many times.

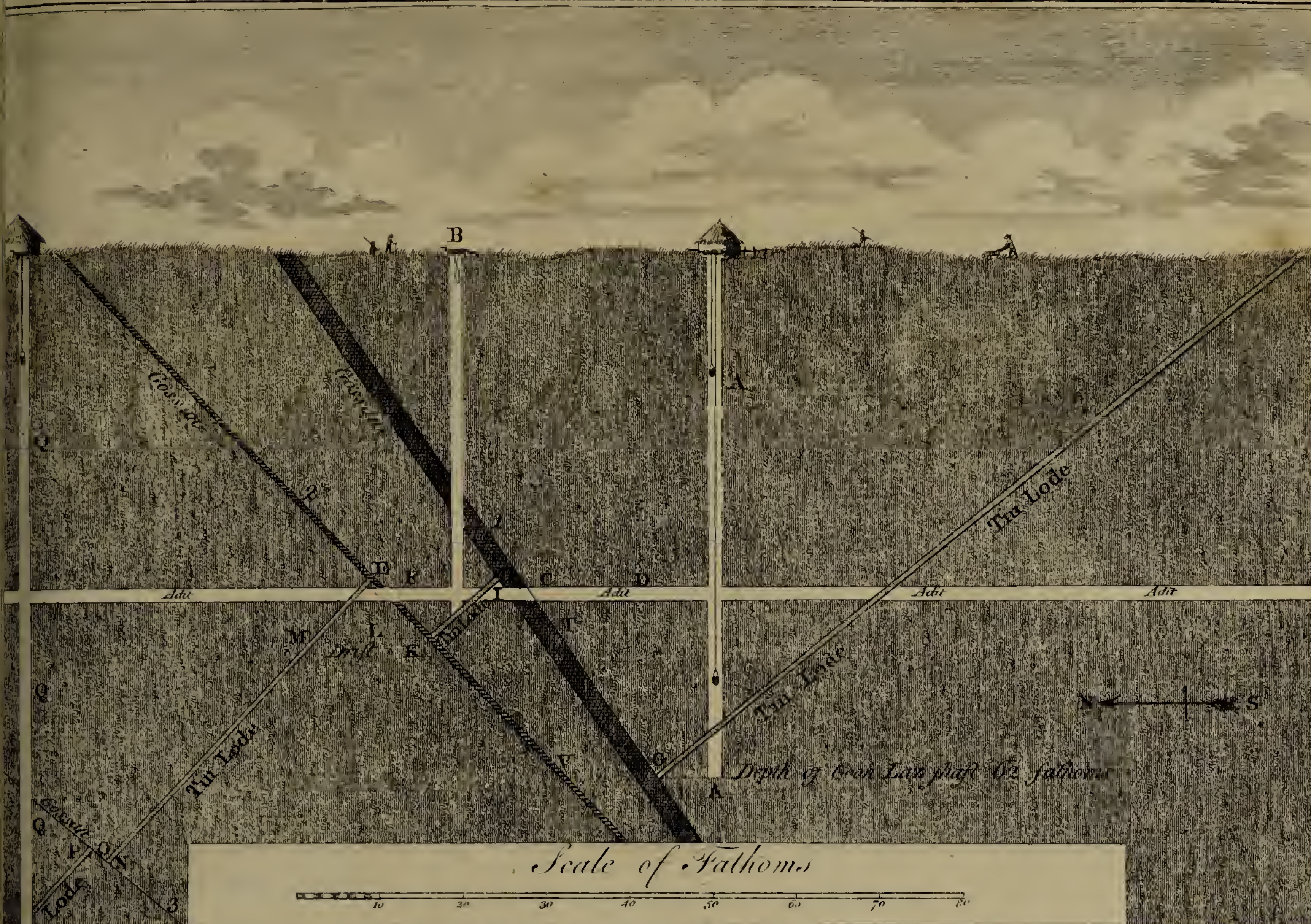
There is another fracture and remove of Lodes, dependent on the fame caufe with the foregoing, which is more truly and commonly called the being "cut out by a Slide." This Slide does not underlie in oppofition to the metallick Lode, as that at Goon-Lâz; but, on the contrary, it comes in behind the Lode, which it interrupts by underlying fafter. This Slide is compofed of a fine unctuous gray or white clay; is feldom fix inches big; and the remove is rarely fix feet

 diftance.

diſtance. Let A A repreſent the true or metallick Lode, and B B B the Slide, and the fracture and remove will be ſeen at one glance; whence the reader may judge for himſelf, how expeditiouſly and certainly the metallick Lode may be recovered.

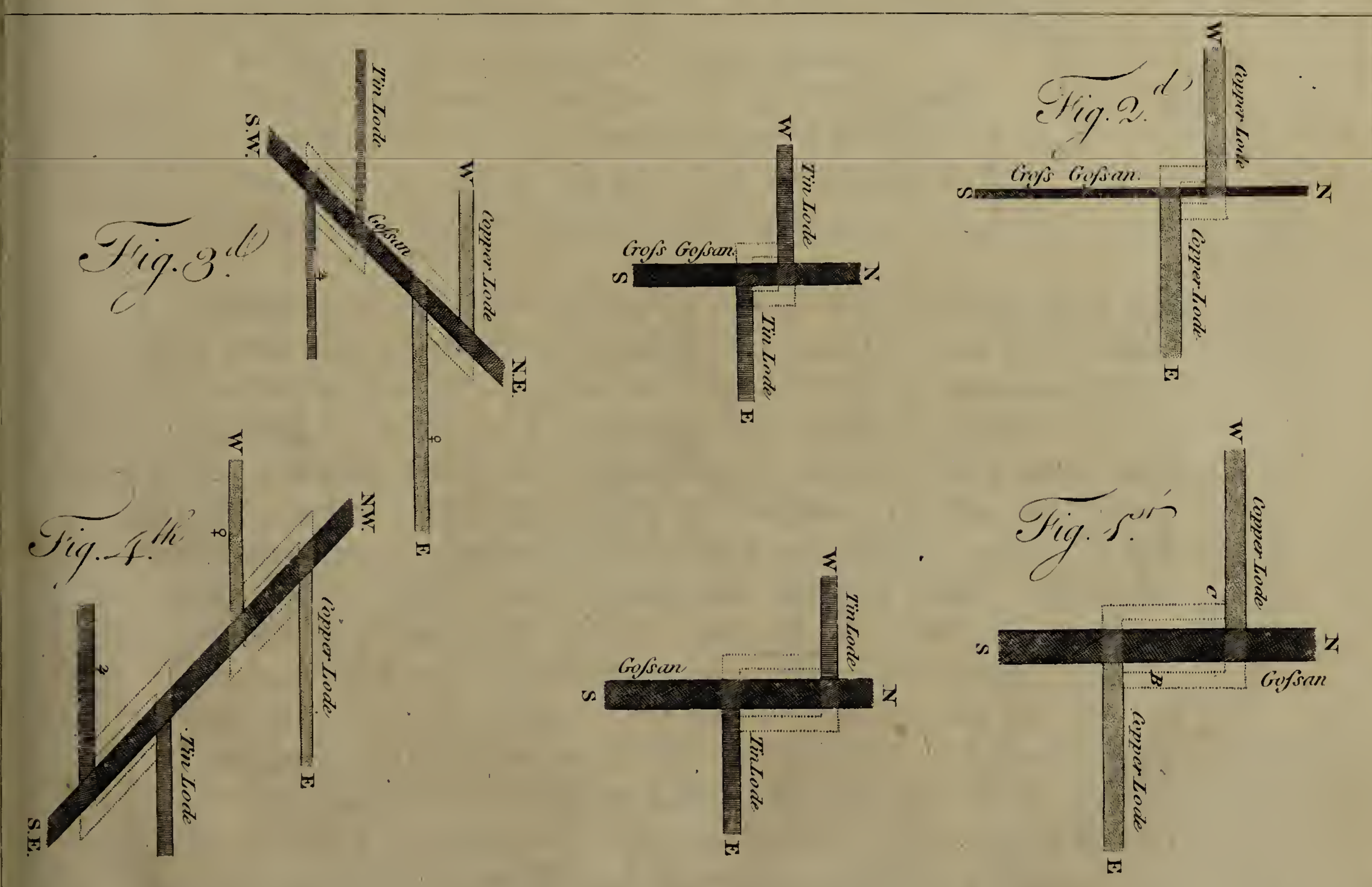


BOOK

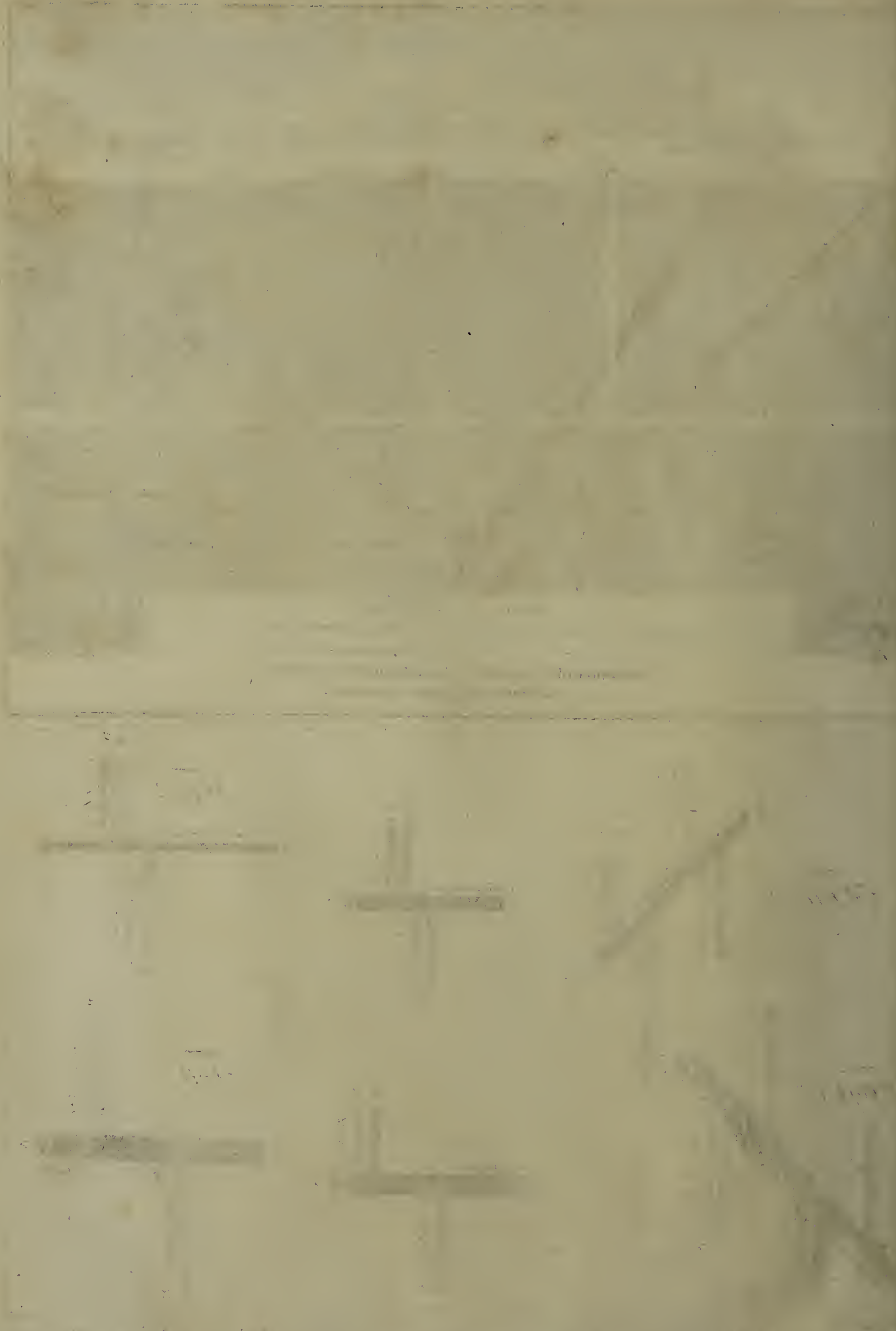


C.F. del.^t Barber sculp.

A Section of GOON-LAZ and the PINK MINE,
in the Parish of S.^t Agnes, Cornwall.



To Sir William Lemon of Carclew Bar.^t M.P.
for the County of Cornwall
This **PLAN** *and* **SECTION** *Engraved at his Expence*
is most gratefully Inscribed by W.^m Pryce.



BOOK III.

CHAP. I.

Of the various Methods of difcovering Mines.

LUCRETIUS, who afcribes the firft difcovery of Metals to the burning down of woods, fays, that the heat of the flames melted the Metals, which were difperfed here and there in the veins of the earth, and made them flow into one mafs:

Whatever 'twas that gave thefe flames their birth,
Which burnt the tow'ring trees, and fcorch'd the earth;
Hot ftreams of Silver, Gold, and Lead, and Brafs,
As nature gave a hollow, proper place,
Defcended down, and form'd a glitt'ring mafs.
This when unhappy Mortals chanc'd to fpy,
And the gay colour pleas'd their childifh eye;
They dug the certain caufe of mifery.

Cadmus, the Phenician, is, by fome, faid to have been the firft who difcovered Gold; others fay, that Thoas firft found it, in the mountain Pangæus in Thrace: the Chronicon Alexandrinum, afcribes it to Mercury, the fon of Jupiter; or to Pifus, king of Italy, who quitting his own country went into Egypt; where, after the death of Mifraim, the fon of Cham, he was elected to fucceed him in the royal dignity, and, for the invention of Gold, was called the Golden God. Æfchylus attributes the invention of this, and all other Metals, to Prometheus: and there are others who write, that either Æaclis, whom Hyginus calls Cæacus the fon of Jupiter, or Sol the fon of Oceanus, firft difcovered Gold in Panchaia. Ariftotle fays, that fome fhepherds in Spain having fet fire to certain woods, and heated the fubftance of the earth, the Silver that was near the furface of it, melted, and flowed together in a heap; and that a little while after there happened an earthquake, which cleaved the earth, and difclofed a vaft profufion of Silver. This

This is confirmed by Strabo, lib. iii. and Athenæus, lib. vi. who ſay, that the Mines in Andaluſia were diſcovered by this accident. Cinyra the ſon of Agryopa, firſt found out the Braſs (Copper) Mines in Cyprus; and the diſcovery of Iron Mines Heſiod aſcribes to thoſe in Crete who were called Dactyli Idæi: and Midacritus was the firſt man that brought Lead (Tin) out of the iſland Caſſiteris. (Lucretius, Pliny, Polydore Virgil).

We ſhall cloſe this ancient account of the firſt diſcovery of Metals, with the following lines from Dr. Garth's Diſpenſary.

Now thoſe profunder regions they explore,
Where Metals ripen in vaſt cakes of Ore.
Here, ſullen to the ſight, at large is ſpread,
The dull unweildy maſs of lumpiſh Lead;
There, glimmering in their dawning beds, are ſeen
The more aſpiring ſeeds of ſprightly Tin;
The Copper ſparkling next in ruddy ſtreaks,
And in the gloom betrays its glowing cheeks.

Mines have been often diſcovered by accident, as in the ſea cliffs, among broken craggy rocks, or by the waſhing of the tides or floods; likewiſe by irruptions and torrents of water iſſuing out of hills and mountains; and ſometimes by the wearing of high roads. Another way of finding veins, which we have heard from thoſe whoſe veracity we are unwilling to queſtion, is by igneous appearances, or fiery coruſcations. The Tinners generally compare theſe effluvia to blazing ſtars, or other whimſical likeneſſes, as their fears or hopes ſuggeſt; and ſearch, with uncommon eagerneſs, the ground which theſe jack o' lanthorns have appeared over and pointed out. We have heard but little of theſe phenomena for many years; whether it be, that the preſent age is leſs credulous than the foregoing; or that the ground being more perforated by innumerable new pits ſunk every year, ſome of which by the Stannary laws are prohibited from being filled up, has given theſe vapours a more gradual vent; it is not neceſſary to enquire, as the fact itſelf is not generally believed. The art of Mining, however, does not wait for theſe favourable accidents, but directly goes upon the ſearch and diſcovery of ſuch Mineral Veins, Ores, Stones, &c. as may be worth the working for Metal. The principal inveſtigation and diſcovery of Mines, depends upon a particular ſagacity, or acquired habit of judging from particular ſigns, that metallick matters are contained in certain

certain parts of the earth, not far below its ſurface. But, as ignorance and credulity are the portions of the illiterate, we have people conſtantly in ſearch for Tin, where our dreaming geniuſes direct them to follow after the images of wild fancy; conſequently, we have a Huel-dream in every Mining pariſh, which raiſes and diſappoints by turns the ſanguine hopes of the credulous adventurers.

Mines are alſo diſcovered by the harſh diſagreeable taſte of the waters which iſſue from them, eſpecially thoſe of Copper: but this ſeems to be, only when the Ore is above the level at which the water breaks out; for, otherwiſe, it is unlikely that the water ſhould participate of much impreſſion or quality from the Ore that is underneath it, or untouched by it. A better expedient to find whether the water is impregnated with Copper, is to immerge a piece of bright Iron in it, for two or three days; in which time, the Iron will look of a Copper colour, provided the water is of a cupreous quality, or at leaſt contains a certain ſhare of vitriolick acid: further, if ſome Aqua Fortis be affuſed to a little of this water, in a clear phial, it will preſently exhibit a bluiſh green colour, either fainter or fuller according as it is impregnated with the acid of vitriol. A candle or piece of tallow put into the ſame water for a few days, may be taken out tinged of a green colour.

Hooſon ſays, that "the firſt inventor of the Virgula Divinatoria, was hanged in Germany as a cheat and impoſtor:" on the other hand, Dr. Diederick Weſſel Linden ſays, in anſwer to him, that "Dr. Stahl, when he was preſident of a chemical ſociety in his country, publiſhed a reward of twenty-five ducats for any body that could prove who was the inventor of the Virgula Divinatoria." It is impoſſible to aſcertain the date or perſonality of this diſcovery, which appears to me of very little conſequence to poſterity: but perhaps we may not be far off from the truth, if we incline to the opinion of Georgius Agricola, in his excellent latin treatiſe De Re Metallica, that "the application of the inchanted or divining rod to metallick matters, took its riſe from magicians, and the impure fountains of inchantment." Now the ancients not only endeavoured to procure the neceſſaries of life by a divining or inchanted rod, but alſo to change the forms of things by the ſame inſtrument: for the magicians of Egypt, as we learn from the Hebrew writings, changed their rods into ſerpents; and, in Homer, Minerva turned Ulyſſes when old into the likeneſs

 of

of a young man, and again to his former appearance: Circe alſo changed the companions of Ulyſſes into beaſts, and again reſtored them to the human ſhape; and Mercury, with his rod called Caduceus, gave ſleep to the wakeful, and awakened thoſe that were aſleep. And hence, in all probability, aroſe the application of the forked rod to the diſcovery of hidden treaſure.

Nevertheleſs we find no mention made of this Virgula before the eleventh century, ſince which it has been in frequent uſe. It was much talked of in France towards the end of the ſeventeenth century; and the corpuſcular philoſophy was called in to account for it. The corpuſcles, it was ſaid, that riſe from the Minerals, entering the rod, determine it to bow down, in order to render it parallel to the vertical lines which the effluvia deſcribe in their riſe. In effect the Mineral particles ſeem to be emitted from the earth: now the Virgula being of a light porous wood, gives an eaſy paſſage to thoſe particles, which are very fine and ſubtle; the effluvia then driven forwards by thoſe that follow them, and preſſed at the ſame time by the atmoſphere incumbent on them, are forced to enter the little interſtices between the fibres of the wood, and by that effort they oblige it to incline, or dip down perpendicularly, to become parallel with the little columns which thoſe vapours form in their riſe.

The primary and moſt ſimple affections of matter, according to the great Mr. Boyle, are (1) Local Motion, (2) Size, (3) Shape, and (4) Reſt. But becauſe there are ſome others, that naturally flow from theſe, and are, though not altogether univerſal, yet very general and pregnant, we ſhall ſubjoin thoſe which are the moſt fertile principles of the qualities of bodies, and other phenomena of nature. Thoſe leſſer fragments of matter, which we call corpuſcles or particles, have certain local reſpects to other bodies, and to thoſe ſituations which we denominate from the horizon; ſo that each of theſe minute fragments may have a particular (5) poſture or poſition, as erect, inclining, horizontal, &c. and as they reſpect us that behold them, there may belong to them a certain (6) order or conſecution, whereby we ſay, one is before or behind another; and many of theſe fragments being aſſociated into one maſs or body, have a certain manner of exiſting together, which we call (7) texture or modification. Almoſt all bodies, and thoſe fluid ones that are made up of groſſer parts, will have (8) pores in them: and very many bodies having particles, which, by their ſmallneſs,

ſmallneſs, or their looſe adherence to the bigger or more ſtable parts of bodies they belong to, are more eaſily agitated, and ſeparated from the reſt by heat and other agents; therefore there will be great ſtore of bodies, that will emit thoſe ſubtle emanations, which are commonly called (9) effluvia.

Each of theſe nine producers of phenomena, admit of a variety ſcarcely credible. For not to deſcend ſo low as inſenſible corpuſcles, (or thoſe which are imperceptible to natural or artificial opticks, many thouſands of them being requiſite to conſtitute the ſize of a muſtard ſeed) what an innumerable company of different bigneſſes may we conceive between the bulk of a mite, (a crowd of which is neceſſary to weigh one grain) and a mountain, or the body of the ſun! Figure, though one of the moſt ſimple modes of matter, is capable of great varieties, partly in regard of the ſurface or ſurfaces of the figured corpuſcles, (which may conſiſt of ſquares, triangles, pentagons, &c.) and partly in regard of the ſhape of the body itſelf, which may be either flat like a cheeſe, ſpherical like a bullet, eliptical like an egg, cubical like a die, cylindrical like a pump, hexagonal pointed like a pyramid, or conical like a ſugar loaf. And yet all theſe figures are few compared to thoſe irregular ſhapes, which are to be met with among rubbiſh, &c. So likewiſe motion, which ſeems ſo ſimple a principle, eſpecially in ſimple bodies, may even in them be very much diverſified; and as to the determination of motion, the body may move directly upwards, or downwards, declining, or horizontally, eaſt, weſt, north, or ſouth, &c. according to the ſituation of the impellent body. There will likewiſe ariſe new diverſifications, from the greater or leſſer number of the moving corpuſcles; from their following one another cloſe, or more at a diſtance, &c. from the thickneſs, thinneſs, pores, and the conditions of the medium through which they move; and from the equal or unequal celerity of their motion, and force of their impulſe: and the effects of all theſe are variable by the different ſituation and ſtructure of the ſenſories, or other bodies, on which theſe corpuſcles act.

Now there are, firſt, many bodies, that in diverſe caſes act not, unleſs they be acted on; and ſome of them act, either ſolely or chiefly as they are acted on by common and unheeded agents. Secondly, there are certain ſubtle bodies that are ready to inſinuate themſelves into the pores of any body diſpoſed to admit their action, or by ſome other way effect it. Thirdly, there are bodies, which, by a mechanical change of texture, may

may acquire or loſe a fitneſs to be wrought upon by ſuch unnoticed agents, and alſo to diverſify their operations on it, upon the force of its varying texture. All theſe propoſitions are proved from the moſt common, though unheeded affairs and occurrencies of human life; as eaſily, as the polarity and magnetiſm of an old Iron bar taken from a church window, where it has ſtood upright for many centuries, is proved to derive its virtue from the magnetick effluvia of the earth.

As many deny, or at leaſt doubt, the attributed properties of the divining rod, I ſhall not take upon me, ſingly to oppoſe the general opinion, although I am well convinced of its abſolute and improveable virtues. It does not become me to decide upon ſo controvertible a point; particularly, as from my natural conſtitution of mind and body, I am almoſt incapable of co-operating with its influence; and, therefore, cannot, of my own knowledge and experience, produce ſatisfactory proofs of its value and excellence. I ſhall, however, give thoſe accurate obſervations on the virtues of the Virgula Divinatoria, which I have been favoured with by my worthy friend Mr. William Cookworthy, of Plymouth, a man, not leſs eſteemed for his refined ſenſe and unimpeachable veracity, than for his chemical abilities. It is to him the publick is indebted for the late improvements in the porcelain manufactory now eſtabliſhed at Briſtol, which, under his direction, is likely to be rendered not leſs elegant and durable than the beſt Aſiatick China.

His firſt knowledge of the rod, he ſays, was from a captain Ribeira, who deſerted the Spaniſh ſervice in queen Ann's reign, and became the capt. commandant in the garriſon of Plymouth; in which town he ſatisfied ſeveral intelligent perſons of the virtues of the rod by many experiments on pieces of Metal hid in the earth, and by the actual diſcovery of a Copper Mine near Oakhampton, which was wrought for ſome years. The captain made no difficulty to let people ſee him uſe the rod, but he was abſolutely tenacious of the ſecret how to diſtinguiſh the different Metals by it, without which, the knowledge of its attraction is of little uſe: but by a cloſe attention to his practice, the writer has diſcovered this, and made many other diſcoveries of its properties, which he is willing ſhould be publiſhed, being fully perſuaded of the great utility of this inſtrument in Mineral undertakings; and the reader may be aſſured, that he is fully convinced of the truth of what he communicates from abundant and very clear experience.

Captain

Captain Ribeira held, that rods cut from the nut or other fruit-bearing trees, were the only proper ones for this ufe ; and that the virtue was confined to certain perfons, and thofe comparatively few. Agricola fays, "If the attractive power of veins does not "turn the rod, when in the hands of fome particular metallifts "or others, it is owing to fome fingular occult quality in the "holder, which impedes and reftrains the attractive power ; "for fince that power moves and turns the rod, in the fame "manner as the Lodeftone invites and attracts Iron, it is "debilitated and deftroyed by the occult quality in the holder, "juft as garlick weakens and excludes the attractive quality of "the magnet, for a magnet rubbed over with juice of garlick "does not draw Iron." But this proves to be a miftake of captain Ribeira ; for the virtue, as he calls it, refides in all perfons, and in all rods, under the circumftances hereafter defcribed.

The rod is attracted by all the Metals, by Coals, Bones, Limeftone, and Springs of Water, with different degrees of ftrength in the following order : 1 Gold, 2 Copper, 3 Iron, 4 Silver, 5 Tin, 6 Lead, 7 Coals, 8 Limeftone and Springs of Water. One method to determine the different attractions of the rod, is this : Stand, holding the rod, with one foot advanced ; put a guinea under that foot, and a halfpenny under the other, and the rod will be drawn down ; fhift the pieces of money, and the rod will then be drawn towards the face or backwards to the Gold, which proves the Gold to have the ftronger attraction. By trying all the fubjects of the rod in the fame manner, their refpective attractions in point of ftrength will be found to correfpond with the order in which I have already placed them.

The rods formerly ufed, were fhoots of one year's growth that grew forked, as figures 1 and 2, plate 2 ; but it is found, that two feparate fhoots tied together with fome vegetable fubftance, as packthread, will anfwer rather better than thofe which are grown forked, as their fhoots being feldom of equal length or bignefs they do not handle fo well as the others, which may be chofen of exactly the fame fize. The fhape of the rod thus prepared, will be between 2½ and 3 feet long, like fig. 3, plate 2. They muft be tied together at their great or root ends, the fmaller being to be held in the hands. Hazle rods cut in the winter, fuch as are ufed for fifhing rods, and kept till they are dry, do beft ; though where thefe are not at hand, apple-

 tree

tree fuckers, rods from peach-trees, currants, or the oak, though green, will anfwer tolerably well.

It is very difficult to defcribe the manner of holding and ufing the rod: it ought to be held in the hands, in the pofition fig. 4, plate 2, the fmaller ends lying flat or parallel to the horizon, and the upper part in an elevation not perpendicular to it, but 70 degrees, as fig. 4, plate 2.

Alonzo Barba directs the rod to be fixed acrofs the head of a walking ftick in form of a T, and the end which is neareft the root will dip or incline to the Mineral Ore.

The rod being properly held by thofe with whom it will anfwer, when the toe of the right foot is within the femi-diameter of the piece of Metal or other fubject of the rod, it will be repelled towards the face, and continue to be fo, while the foot is kept from touching or being directly over the fubject; in which cafe, it will be fenfibly and ftrongly attracted, and be drawn quite down. The rod fhould be firmly and fteadily grafped; for if, when it hath begun to be attracted there be the leaft imaginable jirk, or oppofition to its attraction, it will not move any more, till the hands are opened and a frefh grafp taken. The ftronger the grafp the livelier the rod moves, provided the grafp be fteady, and of an equal ftrength. This obfervation is very neceffary, as the operation of the rod in many hands is defeated purely by a jerk or counter action; and it is from thence concluded, there is no real efficacy in the rod, or that the perfon who holds it wants the virtue; whereas by a proper attention to this circumftance in ufing it, five perfons in fix have the virtue as it is called; that is, the nut or fruit bearing rod will anfwer in their hands. When the rod is drawn down, the hands muft be opened, the rod raifed by the middle fingers, a frefh grafp taken, and the rod held again in the direction defcribed.

A little practice by a perfon in earneft about it, will foon give him the neceffary adroitnefs in the ufe of this inftrument: but it muft be particularly obferved, that as our animal fpirits are neceffary to this procefs, fo a man ought to hold the rod, with the fame indifference and inattention to, or reafoning about it or its effects, as he holds a fifhing rod or a walking ftick; for if the mind be occupied by doubts, reafoning, or any other operation that engages the animal fpirits, it will divert their powers from being exerted in this procefs, in which their

inftrumentality

inftrumentality is abfolutely neceffary; from hence it is, that the rod conftantly anfwers in the hands of peafants, women, and children, who hold it fimply without puzzling their minds with doubts or reafonings. Whatever may be thought of this obfervation, it is a very juft one, and of great confequence in the practice of the rod.

If a rod, or the leaft piece of one, of the nut bearing or fruit kind, be put under the arm, it will totally deftroy the operation of the Virgula Divinatoria in regard to all the fubjects of it, except water, in thofe hands in which the rod naturally operates. If the leaft animal thread, as filk, or worfted, or hair, be tied round or fixt on the top of the rod, it will in like manner hinder its operation; but the fame rod placed under the arm, or the fame animal fubftances tied round or fixt on the top of the rod, will make it work in thofe hands, in which, without thefe additions, it is not attracted.

The willow, and other rods, that will not anfwer in the hands, in which the fruit or nut bearing rods are attracted, will anfwer in thofe hands in which the others will not; fo that all perfons ufing fuitable rods in a proper manner, have the virtue as it is called of the rod. A piece of the fame willow placed under the arm, or the filk, worfted, or hair, bound round, or fixt to the top of it, will make it anfwer with thofe to whom the nut or fruit bearing rods are naturally fuitable, and in whofe hands without thofe additions it would not anfwer.

All rods, in all hands, anfwer to fprings of water.

A piece of Gold held in the hand, and touching the rod, will not only hinder its being attracted by this Metal; but, on the contrary, the rod will be repelled towards the face. It is the fame in regard to Copper as well as Gold, if the latter is held in the hand.

If Iron is fo held, the rod will be repelled by that means. If any of the white Metals, viz. Silver, Lead, or Tin, be held in the hand, the rod will not be attracted, but repelled by all thofe Metals. It is the fame with Limeftone, Bone, and Coal. And, vice verfa, if a perfon with whom the rod doth not naturally operate, holds a piece of Gold in his hand, the rod will then be attracted by Gold and Copper. The fame holds good with all fubjects of the rod.

On

On thefe properties of the rod, depends the practice of diftinguifhing one Metal or fubject from another. There is, however, another way of diftinguifhing, drawn from the fame principles, but much more certain and ready than the former; and that is by preparing rods, that will only operate on Gold and Copper, Iron, the white Metals, Coals, Bones, and Limeftone.

Thus, if a rod is wanted for diftinguifhing Copper or Gold, procure filings of Iron, Lead, and Tin, fome leaf Silver, Chalk in powder, Coal in powder, and rafped bones: let a hole be bored with a fmall gimlet in the top of the rod; then mix the leaft imaginable quantity of the above ingredients, and put it in the gimlet hole with a peg of the fame wood with the rod, when it will only be attracted by what is left out, viz. Gold and Copper.

In preparing a rod for diftinguifhing the white Metals, leave out the Lead, Tin, and leaf Silver, and add Copper filings to the other ingredients; and fo of every fubject by which you would have the rod attracted, the refpective filings, or powder, muft be left out of the mixture, which is to be put into the hole, at the top of the rod. As for Coal and Bones, they may be omitted in the diftinguifhing rods that are ufed in Cornwall, for obvious reafons: but it is neceffary to put in the Chalk or Lime; for though there is no Limeftone in the Mining part of the county, yet there are abundance of ftrata that draw the rod as Limeftone; for the diftinction of a dead or a live courfe, holds as well in regard to Limeftone, as to the Metals. This, however paradoxical it may appear, is a truth eafily to be proved; and it is one axiom in the fcience of the rod, that it makes no diftinction between the living and dead parts of a courfe. Like the Lodeftone, it only fhews the courfe, leaving the fuccefs of the undertaking, to the fortune, fkill, and management of the Miner; as the Lodeftone doth that of the voyage, to the fortune, ability, and prudence of the mariner and merchant.

It is advifable for young beginners to make no experiments but about actual Lodes, where the backs of them are known by the Miners; or elfe nigh the fea, where a Lode being difcovered, they may trace it to the cliffs, and will be fure to find it.

The

The rod being guarded againſt all ſubjects except that which you want to diſcover, as Tin and Copper for example; walk ſteadily and ſlowly on with it; and a perſon that hath been accuſtomed to carry it, will meet with a ſingle repulſion and attraction, every three, four, or five yards, which muſt not be heeded, it being only from the water that is between every bed of Killas, Grouan, or other ſtrata. When the holder approaches a Lode ſo near as its ſemidiameter, the rod feels looſe in the hands, and is very ſenſibly repelled toward the face; if it is thrown back ſo far as to touch the hat, it muſt be brought forward to its uſual elevation, when it will continue to be repelled till the foremoſt foot is over the edge of the Lode: when this is the caſe, if the rod is held well, there will firſt be a ſmall repulſion towards the face; but this is momentary; and the rod will be immediately drawn irreſiſtibly down, and will continue to be ſo in the whole paſſage over the Lode; but as ſoon as the foremoſt foot is beyond its limits, the attraction from the hindmoſt foot, which is ſtill on the Lode, or elſe the repulſion on the other ſide, or both, throw the rod back toward the face. The diſtance from the point where the attraction begun, and where it ended, is the breadth of the Lode; or rather, of a horizontal ſection of the bryle or back juſt under the earth. We muſt then turn, and trace it on obliquely, or in the way of zig zag, as far as may be thought neceſſary.

In the courſe of this tracing a Lode, all the circumſtances of it, ſo far as they relate to its back, will be diſcovered; as its breadth at different places, its being ſqueezed together by hard ſtrata, its being cut off and thrown aſide from its regular courſe by a Croſs-Goſſan, &c.

In order to determine this, it will be neceſſary, that ſome one preſent ſhould either cut up a turf, or place a ſtone at the places where the rod began, and on the other ſide where it ceaſed to be attracted.

The draughts, in plate 2, of Veins parted and proved according to the above directions, may make this ſufficiently clear. The dots repreſent the turf or ſtone; and the zig zag, the line in which the operator moves in purſuing the Vein. Fig. 5, is a Lode going on eaſt and weſt regularly, with the repulſion expreſſed by the lines north and ſouth on each ſide. Fig. 6, is a Lode ſqueezed by a hard ſtrata in ſome places almoſt to a ſtring. Fig. 7, is a Lode cut off by a Croſs-Goſſan, wherein the method for difcovering of the feparated part is obvious to any intelligent Miner, upon the fame line at grafs with the rod, as underground with the Pick and Gad.

In tracing a Lode for a confiderable length, there is no neceffity for the zig zag traverfing, but it may be done according to the delineation fig. 8, wherein the operator endeavours to keep the middle of the Lode, and turns when the rod, by its repulfion, intimates that he is got beyond it.

If the rod is well held, its motion is furprifingly quick and lively: nothing is neceffary, but to keep the mind indifferent, to grafp the rod pretty ftrongly, and fteadily; opening the hands, and raifing the rod with the middle fingers, every time it is drawn down. If the rod is raifed and replaced without opening the hands, it will not work.

The difcovery of the Metal a Lode is naturally difpofed to contain, is very eafy: try it with a diftinguifhing rod; if it attracts it, it contains the Metal that is left out of the mixture at the top of that rod; if it draws more than one rod, the Lode is compounded of thofe Metals.

Copper Lodes generally draw the rod diftinguifhing Iron, becaufe of the ferruginous Goffan contained in them; but Tin Lodes frequently draw none but their proper rod, unlefs Gal, which is a kind of Iron Ore, is intermixed.

It has been faid above, that the rod makes no diftinction between the living or dead parts of a Lode: though this is invariably true, yet this inftrument is of great ufe, as it helps us to trace any known Lode from the fpot where it is wrought, through other people's lands who might be willing to try it.

If the Lode is alive to its top, or as it is ufually phrafed by the Tinners, To Grafs; more work may be done in the way of difcovery with the rod in a quarter of an hour, than by the ufual methods in months, as a perfon has nothing to do, but to open the Lode immediately at grafs, and difcover its fize and underlie, which may be done at a trifling expence.

The difcovery of Crofs-Goffans by the rod, is a property which may be ufefully employed in Mining, particularly in driving

driving adits, as the driving an adit through a Crofs-Goffan is much eafier than through the country.

In feeking for water by the rod, no notice is to be taken of thofe fingle attractions of the rod which are occafioned by the commiffures or crevices (called Cafes of Water by the Tinners) between the courfes or diftinct runs of Killas ; but a vein muft be found, which anfwers to the rod as a Metal, and if this is funk unto a proper depth, a good quantity of water will be difcovered.

It may not be amifs to clofe this little effay on the Virgula Divinatoria, with fome few ftriking inftances of courfes, that have been cut by means of it in Cornwall.

A quantity of grain Tin having been found in the pond at Heligan, the feat of the reverend Mr. Henry Hawkins Tremayne; and it being a queftion, whether this Tin might not come from fome neighbouring Lode, it was difcovered by the rod and funk upon ; but it proved a barren Vein for Metal in any quantity. A fhaft was funk at St. Germains, near the houfe of Francis Fox, to difcover water ; it drew the rod as Iron, and contained Mundick : another fhaft was funk between Penzance and Newlyn, according to the direction of the rod ; the faft lay deep beneath the furface, but a Lode containing much Mundick was difcovered. In a clofe juft by St. Auftle, to fatisfy the curiofity of fome gentlemen, Mr. Cookworthy difcovered by the rod the back of a Lode that had been wrought, but not turning to advantage the undertaking had been dropped, and the ground levelled. This Lode was traced juft as the Miners informed the gentlemen it ran ; and the Lode appearing by the rod at a certain place to be fqueezed to nothing, the Miners declared this alfo to be true ; for at this very fpot where the Lode was thus fqueezed, they loft it. Being required to difcover a Lode that had been tried in the cliff under St. Auftle Down, he found it in the country by the rod, and traced it to the cliff. It was a large Goffan-Lode ; and as the attraction was found to ftop, and after paffing on a foot or two to begin again, he declared this was a cleft Lode, and had what the Miners call a Horfe in it, which the Miners prefent who had wrought in it declared to be true.

Hence it is very obvious, how ufeful the rod may be for difcovery of Lodes, in the hands of an adept in that fcience ; but

but it is remarkable, that although it inclines to all Metals in the hands of unſkilful perſons, and to ſome more quick and lively than to others, yet it has been found to dip equally to a poor Lode, and to a rich one. I know that a grain of Metal attracts the Virgula, as ſtrongly as a pound; nor is this any diſadvantage in its uſe in Mining; for if it diſcovered only rich Mines, or the richer parts of a Mine, the great prizes in the Mining lottery would be ſoon drawn, and future adventurers would be diſcouraged from trying their fortune. But, indeed, we are ſo plentifully ſtored with Tin and Copper Lodes, that ſome accident every week diſcovers to us a freſh Vein; rich Mines having been ſeveral times diſcovered by children playing, and digging pits in imitation of ſhafts, whereby profits have ariſen to their parents and others; and theſe puerile diſcoveries have in ſundry places borne the name of Huel-Boys to this day.

Another way of diſcovering Lodes is by ſinking little pits through the looſe ground, down to the faſt or ſolid country, from ſix to twelve feet deep, and driving from one to another acroſs the direction of the Vein; ſo that they muſt neceſſarily meet with every Vein lying within the extent of theſe pits; for moſt of them come up as high as the ſuperficies of the firm rock, and ſometimes a ſmall matter above it. This way of ſeeking, the Tinners call Coſteening, from Cothas Stean; that is, fallen or dropt Tin.

Another and very ancient method of diſcovering Tin Lodes, is by what we call Shodeing; that is, tracing them home by looſe Stones, fragments, or Shodes (from the Teutonick Shutten to pour forth) which have been ſeparated, and carried off, perhaps, to a conſiderable diſtance from the Vein, and are found by chance in running waters, on the ſuperficies of the ground, or a little under.

When the Tinners meet with a looſe ſingle ſtone of Tin Ore, either in a valley, or in plowing, or hedging, though at a hundred fathoms diſtance from the Vein it came from; thoſe who are accuſtomed to this work, will not fail to find it out. They conſider, that a metallick Stone muſt originally have appertained to ſome Vein, from which it was ſevered and caſt at a diſtance by ſome violent means. The deluge, they ſuppoſe, moved moſt of the looſe earthy coat of the globe; and, in many places, waſhed it off from the upper, towards the lower grounds, with ſuch a force, that moſt of the backs of Lodes or Veins which protruded

protruded themfelves above the faft, were hurried downwards with the common mafs : whence the fkill in this part of their bufinefs, lies much in directing their meafures according to the fituation of the furface.

Upon the top of moft Tin Lodes, in the fhelf or ftratum under the loofe mould and rubbifh of the earth, is that mineralized fubftance, which is called the Broil or Bryle of the Lode. Though it is a part of the Lode, yet it is different in fituation and appearance from all other parts of it ; forafmuch as it is not confined between two walls, the ftratum fo near the furface being of a more lax tender texture, than in the folid rock a fathom or two under it. The Bryle, therefore, is very loofe, and in fome places fcarcely metallick, for want of depth, and of thofe lateral chinks and cracks, which feed and nourifh the Lode, at deeper levels, with Mineral principles educed from the ftrata of the earth.

Such is the Bryle of a Lode ; confequently, when the waters of the deluge retired into their refervoir, great part of the Bryles of Lodes were carried off by the force of the waters to various diftances, according to the gravity of Shode Stones, and the declination of the plane upon which they were difperfed. Tinners who defcribe this diftribution of Shode, to make it more eafily underftood, compare it to a bucket of water difcharged upon the declivity of a hill ; near the bucket, it will take up but a fmall fpace ; but as it defcends, will fpread wider, in the manner of a truncated cone.

Hence it is manifeft to reafon and experience, that the more diftant Shodes are from the Bryle of the Lode, the more diverged they are, and fewer in number ; and, by parity of reafoning, they are more in quantity near to the Bryle, and are collectively in lefs fpace. Neverthelefs, in fome certain fituations, they are in greater quantities in valleys, than on the tops or fides of hills ; but fuch are fmaller, and more eafily carried down by water, and formed into ftrata, which furnifh our ftream works. In level ground, they are found fcarcely removed from the Bryle ; but on a declivity, they are always found difperfed on the fides of the hill, at a greater or lefs diftance, in proportion to the length or declivity thereof, and their own fpecifick weight : confequently, the heavieft Stones are neareft to the Lode, and the lighter are protruded to a greater diftance (even to five miles diftance, as it is faid in Philos. Tranfactions no. 69)

 which

which are alfo nearer to the foil, by means of their levity and fize; while the more grofs and weighty lie deeper interred as they are nearer the Lode. It is almoft needlefs to obferve, that as the texture, gravity, and black or brown colours of Tin Shodes, are different from all others; fo they are thereby known and diftinguifhed, as well as by the fmoothnefs of them a great diftance from the Lode, and the acutenefs of their angles when near to it; which entirely depends upon the trituration they have undergone, rolling over rough furfaces, by the force of water, and the attrition of other bodies paffing over them.

Henckell and Rofler fay, "That Mundick Shode is very "common; and that Wolfram, Granate, and Iron Corns, nay "Quickfilver, are found in Shode and Stream." "All of which," Henckell further fays, "were wafhed and tore away from their "Veins, by the violence of the Noachian deluge."

Copper and Lead Shodes are very feldom met with; yet fuch there are. Their Bryles being chiefly compofed of tender unmetallick Goffan, is not fo well difpofed for bearing that force and attrition, as the more ftoney matter of Tin Lodes are; and the former generally is not mineralized into Copper Ore at the Bryle.

It is a miftake in thofe who deny the exiftence of any other Shode but Tin; fo far from it, every hard ftratum of the earth which is uppermoft, will fhew us numbers of their Shodes difperfed from them at a diftance, and reclined upon ftrata of quite different natures, as hills and vallies are fituated to help forward or retain thofe rocky fragments. I think our diftinct loofe Moorftone, or Granite rocks, upon the fides, and at the bottoms of our mountains, are the Shodes of their ftrata underneath; and many large Shodes of Ireftone are to be feen, though in lefs plenty, difperfed upon Killas ftrata at a diftance from their parent rock: all of which are inconteftible witneffes of thofe violent conquaffations and convulfions of our country, at the time of the flood.

It is much to be lamented, that the fcience of Shoding is greatly loft in the prefent age. Among all our Miners, we have not fifty, who fcientifically or experimentally underftand any thing of the matter; and thofe that are intelligent therein, are become old and feeble; whereby it is much to be feared, that

that this useful, and I think improveable science, is in danger of being practically lost.

Almost every Lode has a peculiar coloured earth or grewt (grit) about it; which is also sometimes found with the Shode, and that in greater quantity, the nearer the Shode lies to the Lode; beyond which that peculiar grewt is seldom found with the Shode. A valley may happen to lie at the feet of three several hills, and then they may find several deads grewt or earth moved by the waters of the deluge, but not contiguous to the Lode, with as many different Shodes in the middle of each. This is also termed the Run of the country; and here the knowledge of the cast of the country, or each hill in respect of its grewt, will be very necessary, for the surer tracing them one after the other as they lie in order.

Likewise, when the Miners find a good Stone of Ore or Shode in the side or bottom of a hill, they first of all observe the situation of the neighbouring ground, and consider whence the deluge could most probably roll that Stone down from the hill; and at the same time they form a supposition, on what point of the compass the Lode takes its course: for if the Shode be Tin, or Copper Ore, or promising for either, they conclude that the Lode runs nearly east and west; but if it is a Shode of Lead Ore, they have equal reason to conclude that the vein goes north and south. After finding the first Stone or Shode, they sink little pits as low as the fast rubble, which is the rubble or clay never moved since the flood, to find more such Stones; and if they meet with them, they go further up the hill in the same line, or a little obliquely perhaps, and sink more pits still, while they find Shode Stones in them; but they seldom sink those pits deeper than the rubble upon the shelf, except they are near the Lode. If the Shode is found in the vegetable soil, the Lode is not at hand; but if it lies deep, massy, and angular, it is a certain sign that the Lode is not far off; more especially if the Shodes are of a pyramidal or conical form, and the base or heaviest part of them lies pointing one way, it is both a sign that the Lode is not far off, and that it is to be found opposite to the base or heaviest part of the Stones.

The account which the learned Alvaro Alonzo Barba gives of discovering Silver Mines, by what I take to be Shoding; is very much like mine, and is as follows, p. 79. "The Veins of "Metal are sometimes found by great Stones above ground; "and

" and if the Veins be covered, they hunt them out after this " manner, viz. taking in their hands a fort of mattock (a pick) " which hath a fteel point at one end to dig with, and a blunt " head at the other to break ftones with, they go to the " hollows of the mountains, where the downfall of rain de- " fcends, or to fome other part of the fkirts of the mountains, " and there obferve what Stones they meet withal, and break " in pieces thofe that feem to have any Metal in them; whereof " they find many times both middling fort of Stones, and fmall " ones alfo of Metal. Then they confider the fituation of that " place, and whence thefe Stones can tumble, which of " neceffity muft be from higher ground, and follow the tract " of thefe Stones up the hill, as long as they can find any of " them," &c.

But to return—As they advance thus nearer the Lode with their pits, they find their Shode more plentiful and deeper in the ground; but if they chance to go further from the Lode, or pafs the yonder fide of it, there is a greater fcarcity of the Shode, or perhaps none at all: in which cafe, they return to their laft pit which produced Shode moft plentifully, and work the intermediate ground, with more care and circumfpection, by drifts from one pit to the next, until they cut the Lode. Sometimes they find two different Shodes in the fame pit at different depths; then they are fure, that there is another Lode further on; and in training up to the fecond, they may meet with the Shode of a third. However, when they are juft come to the Vein they fet out for, they find an uncommon quantity of Shode Stones anfwering to the defcription before given, and then they fay, that they have the Bryle of the Lode; upon which they dig down into the folid hard rock, which was never moved or loofened, until they open the Lode, and find its breadth by the walls in which it is enclofed.

Some Lodes, however, are fo difpofed, that they yield no Shode at all, nor are they to be difcovered in a good depth; which may happen to be the cafe for feveral reafons. The fituation of fome places might have preferved their Veins from having their furfaces torn up and difperfed by the flood; or elfe, being fo much torn and difturbed, their loofe Bryle might have been totally carried off to a vaft diftance, towards which its poverty for Metal and confequential levity might contribute; in the place of which, a fediment or earthy part might have fettled, and buried the Lodes fo deep, that they are not

difcoverable

difcoverable by fhoding. Again, the backs of fome Veins are depreffed, and fo deep under the firm folid rock which lies over them, that they do not make a rife or back immediately up to the loofe ftone or earth; that is to fay, fome Lodes make no back at all, and therefore produce no Shode, fo that it is impoffible to difcover them, except by fome favourable accident, of which I have known feveral inftances.

Thefe different difpofitions of the ftrata I have taken notice of, fometimes deceive the Miners in fhoding for Veins; for when they fuppofe that there is but one bed or layer of ftones or earth over the firm ground, and there happens to be a double ftratum of rock and rubble between, which is far from being uncommon, perhaps they dig no deeper than the firft fhelf; in other words, they dig no deeper than till they think they are come down almoft to the faft or firm ground, where they expect to find either the Shode or the Bryle of the Lode; but as they are covered by the other fhelf or ftratum, which the Miners are not apprized of, they have their labour for their pains, in feeking in fuch uncertain ground, which perhaps contains a double or treble fhelf.

The Miners are of opinion, that the waters by their great emotion, did not only remove, and confufe the furface of the earth, but alfo broke the loofer parts of Veins from off their fuperficies or backs; and thereby difordered and removed the face of the earth as deep as the faft and firm rock or ftratum, as I have faid before: and indeed our apprehenfion of the matter very much favours this fuppofition: whence, undoubtedly, thofe Shodes or fragments of Veins are the veftiges or remains of the deluge. Hence it is, that part of the Shode has been rolled down the declivities of hills from the Mines; moreover, that Shode which is found a great way diftant from the Mines, is much more worn and fmoother than that which is nearer to it, as it happens to ftones on the fea fhore, or on the fides of rapid rivers, which are fretted and worn fmooth by the agitation of the waters, and the friction of other bodies. If any perfon will but confider the fea cliffs, he may obferve, in feveral places, that the upper coat or covering of the earth, has been greatly moved and agitated; and that the loofe ftones did preponderate and fubfide on the firm rocks, purfuant to their fpecifick gravities; next thofe, the rubble refided, and over all the pure light earth refted. Yet this order is not abfolutely perfect and without exception; for loofe ftones are often found in the light earth, and on its fuperficies; which by the impetuofity of the waters, and fituation of particular places, were molefted in fubfiding. For we are not to fuppofe our globe to refemble a trough, or the like excavated figure, wherein the varioufly mixed earths are to be regularly difpofed, as in the operation of buddling or wafhing of Ores; but to be of a fpherical arched figure, where the waters, as on a hanging bottom, powerfully rend, and pull it afunder: and this force of the waters we may fuppofe to be greateft at the beginning and end of the deluge.

So likewife, in fome places, the loofe earth and ftone, which cover the firm rocks, lie in ftrata; for immediately on the rock, there may be, for inftance, a layer of fand or clay, and over that a bed of large ftones, and fo alternately ftratum fuper ftratum, for fome depth. Now thefe variations might very well happen on the decreafe of the deluge: for when the flood was high and more at reft, the flimy light earth was depofited downwards; but when the waters came lower, and bent their courfe to the beach, then it came to pafs that there was a ftrong current from off the land to the fea, which rolled down the loofe ftones upon the mud or fediment that fell and fettled beforehand; fo this current might have been interrupted again by the fituation of the place and interpofition of high ground, till the water had let fall another fediment, and afterwards found or perhaps broke another paffage for itfelf through the land. This might have happened feveral times in the deluge, till at laft the remaining water partly evaporated and partly funk into the ground, leaving the deepeft earth or fediment where it continued longeft; as it happens frequently in floods or overflowings of water, where we may obferve the fituation of high and low grounds do not a little contribute to the fame kind of effects that are here fpoken of.

Another way of difcovering Lodes, is by working drifts acrofs the country as we call it, that is from north and fouth, and vice verfa. I tried the experiment in an adventure under my management, where I drove all open at grafs about two feet in the fhelf, very much like a level to convey water upon a mill wheel; by fo doing I was fure of cutting all Lodes in my way, and did accordingly difcover five courfes, one of which has produced above one hundred and eighty tons of Copper Ore, but the others were never wrought upon. This method of difcovering Lodes, is equally cheap and certain; for a hundred

fathoms

fathoms in a ſhallow ſurface may be driven at fifty ſhillings expence.

In feaſible (tender ſtanding) ground, a very effectual, proving, and conſequential way is, by driving an adit from the loweſt ground, either north or ſouth; whereby there is a certainty to cut all Lodes at twenty, thirty, or forty fathoms deep, if the level admits thereof. Such depths are proving the Lodes diſcovered by them, and the adit will ſerve to drain all parts of the ſtrata above it; and likewiſe be a diſcharge for all water drawn from the Mine into it; ſo that it is effectual for diſcovery, proving for trial, and conſequential to the future working of a Mine. But in Granite, Elvan, and Ireſtone ſtrata, this cannot be complied with, neither is it adviſeable but under certain circumſtances, where the ground is to be wrought for eighteen ſhillings ℔ fathom, unleſs a Croſs-Goſſan lies ready at hand, when the method in uſe is to drive partly on one ſide of the Goſſan, breaking down the adjunct wall of it, whereby they drive the adit cheaply, expeditiouſly, and effectually for diſcovery. In driving adits or levels acroſs, north or ſouth, to unwater Mines already found, there are many freſh Veins diſcovered, which frequently prove better than thoſe they were driving to. Witneſs the Pool adit in Illugan, where the late John Pendarvis Baſſet, Eſq; cleared above one hundred and thirty thouſand pounds.

CHAP. II.

Of Streaming, and Smelting of Stream Tin in the Blowing-Houſe, &c.

WE cannot help repeating in this place, that the deluge is an event which has produced the moſt remarkable alterations in the earth, and to which many effects obſervable at this day are to be aſcribed. The hiſtory of the deluge gives great light towards the knowledge of nature, and the preſent ſtate of the earth ſeems to verify that event: by the violence of the deluge the Mineral kingdom was thrown into confuſion, parts before conjoined were ſeparated, Ores and Veins were diſlodged, and new beds and poſitions given them. The ſeveral ſtrata in which Minerals are at preſent found, afford convincing inſtances, as well of the truth of this event, as of the confuſion wrought by it, eſpecially in parts where Clay, Sand, Rubble, Stone, and the like, lie in beds and layers on each other. But I ſuppoſe there are no particular inſtances under the ſun, that can afford us ſo clear an idea of the flood and its effects, as the Stream works in St. Auſtle, Roach, St. Dennis, St. Stephen's, Luxillian, and Lanlivery.

It happens that what I have already ſaid in my account of ſhode and ſhoding, together with my ſection on the article Tin in chapter the 3d, book the 1ſt, leaves little more for me to ſay on the ſubject of Stream Tin. I muſt, therefore, wave the deſcription of it here, and refer the reader back to thoſe places. Of courſe nothing elſe remains than to deſcribe the manner of Streaming, upon which I ſhall be conciſe becauſe it is a part of my ſubject that is very ſimple and leſs important than deep Mining to the community in general; but as it occurs, in the courſe of my writing, more naturally in conjunction with or immediately after the method of ſhoding, I beg leave to introduce it in this place.

When a Streaming Tinner obſerves a place favourable in ſituation, he takes a leaſe, commonly called a Set, of the land owner or lord of the fee, for ſuch a ſpot of ground, and agrees to pay him a certain part clear of all expence in Black Tin; that is, Tin made clean from all waſte, and ready for ſmelting. The conſideration is generally one ſixth, ſeventh, eighth, or ninth, as can be ſettled between them; or, inſtead thereof, he contracts to employ ſo many men and boys annually in his Stream work, and to pay the land owner, for liberty, from twenty to thirty ſhillings a year for each man, and ſo in proportion for every boy; that is, for twelve ſhillings monthly wages, he articles to pay the lord half as much as for a man.

He then ſinks a hatch (ſhaft) three, five, or ſeven fathoms deep, to the rocky ſhelf or clay; on both of which in the ſame valley, the Tin is frequently ſtratified, without any difference in its being more abundant in one than the other. It is found in different places, in different depths; and ſometimes ſtratified between what is called a firſt, ſecond, or third ſhelf, which is reconcileable upon the principles laid down in my chapter upon ſhoding, &c. The ſtratum of Stream Tin may be from one to ten feet thickneſs or more; in breadth, from one fathom to almoſt the width of the valley; and in ſize, from a wallnut to the fineſt ſand, the latter making the principal part of the Stream,

Stream, which is intermixed with ſtones, gravel, and clay, as it was torn from the adjacent hills.

When he ſinks down to the Tin ſtratum, he takes a ſhovel full of it, and waſhes off all the waſte; and from the Tin which is left behind upon the ſhovel, he judges whether that ground is worth the working or not. If it is proving work, he then goes down to the loweſt or deepeſt part of the valley, and digs an open trench, like the tail or low ſlovan of an adit, which he calls a Level, taking the utmoſt care to loſe no levels in bringing it home to the Stream. This level ſerves to drain and carry off all water and waſte from the workings, in proportion as he hath a weak or powerful current of water to run through it. Some places are very poor and not worth the expence for working; others again are very rich and thence called Beuheyle or Living Stream, as is moſt commonly the caſe if it is of a Grouan nature, which being more lax and ſandy, is more eaſily ſeparated from its native place or Lode, and therefore more abundant and rich in quality according to the known excellence of Grouan Tin.

In the latter caſe, the Streamer carries off what he calls the Overburden, viz. the looſe earth, rubble, or ſtone, which covers the Stream, ſo far and ſo large, as he can manage with conveniency to his employment. If in the progreſs of his working he is hindered, he teems (or lades) it out, with a ſcoop, or diſcharges it by a hand pump: but if thoſe ſimple methods are inſufficient, he erects a rag and chain pump ſo called; or if a rivulet of water is to be rented cheaply at graſs, he erects a water wheel with ballance bobs, and thereby keeps his workings clear from ſuperfluous water, by diſcharging it into his level: mean while his men are digging up the Stream Tin, and waſhing it at the ſame time, by caſting every ſhovel full of it, as it riſes, into a Tye, which is an inclined plane of boards for the water to run off, about four feet wide, four high, and nine feet long, in which, with ſhovels, they turn it over and over again under a caſcade of water that waſhes through it, and ſeparates the waſte from the Tin, till it becomes one half Tin.

Though there is little dexterity in this manœuvre, yet care is requiſite to throw off the Stent or rubble from the tye to itſelf, whilſt another picks out the Stones of Tin from the Garde or ſmaller pryany part of it. During this operation, the beſt of

 the

the Tin, by its fuperior gravity, collects in the head of the tye directly under the cafcade; and by degrees becomes more full of wafte, as it defcends from that place to the end or tail of the tye, where it is not worth the faving. If there is a copious ftream of water near at hand, they caft this refufe into it, by which it is carried fo far as to make its exit into the fea, for which practice they certainly deferve our fevereft cenfure; at leaft, if the choaking of harbours and rivers, and the deftruction of thoufands of acres of improvable meadow land, are not more than an equivalent for the cafual and temporary profits arifing from Stream Tin.

I need not mention, that in the ufual method of Streaming for Tin, the foil is either thrown into the bed of the rivers, or buried under the gravel and ftones that form the interior ftrata; by which fuch land is rendered irreclaimable. That the Bounder, or working Tinner, fhould thus wantonly deftroy what he had no intereft in preferving, feems by no means extraordinary; but can we fay the fame for the lord of the foil?

Surely, it did not require any great degree of penetration, to have comprehended Streaming and Draining under one idea, and thus have made the improvement of the furface go hand in hand with the extraction of the Tin. The additional trouble of removing back the foil in heaps, and levelling the Stream ground to receive it, is fo little that I know, by feveral inftances, the Tinner will have but little reluctance in acceeding to; which the reader will readily apprehend when I affure him, the overburden upon the Stream is digged and rolled off at fome diftance, for only eightpence a cubick fathom; but at all events it is the intereft of the proprietor to have it done, either by the Streamer or fome other perfon. This method has been purfued in fome parts of the county of Cornwall, and has been attended with the fuccefs fo laudable an undertaking merits; as thereby thofe fprings which lie too deep for the ordinary modes of draining, have been moft effectually cured. I hope I fhall not be accufed of exaggeration when I affert, that the rental of this county, by following this obvious method of procedure, might have been increafed in a proportion almoft equal to the prefent value of the Stream Tin; and this too without leffening its produce, or injuring in the fmalleft degree the ducal revenue.

That this practice was not adopted by our anceftors, was owing to the fmall comparative value of land in thofe days, confidering either the ftate of population or the uncertain and precarious tenures under their feudal lords. But when Britons have long fince wrefted, from their petty monarchs, the property of the foil, together with the invaluable privilege of tranfmitting their improvements from father to fon, that a cuftom fo injurious to the community, as well as to the individual, fhould ftill continue;

—— " pudet hæc opprobria nobis
" Et dici potuiffe, et non potuiffe refelli."

After the Tin is thus partly dreffed in the raifing of it, they carry it to grafs; and when a competent quantity is collected, they proceed to drefs it for blowing. There are feveral ways of dreffing this kind of Tin; but the general method is, to make what they call a Gounce, which is nothing more than a fmall tie before defcribed, and what we call in the Mining parts a Strêke, in which the fmaller tin is wafhed over again as was done before in the tye, but with a lefs current of water, and a larger degree of care and caution, left the Tin be carried off with it. The richer part of the Tin, as before mentioned, lies neareft the head of the gounce, which is carefully taken up, divided, or kept feparate, according to its goodnefs, and put into large vats or kieves; while the wafte that lies in the hinder part of the gounce, is dreffed over again, till all the Tin is taken out, and the remaining wafte becomes abfolute refufe. The Tin is then fifted through wood or wire fieves, whereby the greater particles are divided from the fmaller; by this method, likewife, the wafte from its levity lies uppermoft in the fieve, which is carefully fkimmed off, and laid afide to work over again. The fmalleft Tin which paffes through the wire fieve, is put into another finely weaved horfe-hair fieve, called a Dilluer, by which and the fkill of the workman, it is made merchantable. Some of the nodules or lumps of Tin are blowed or fmelted as they come out of the tie; but thofe which are mixed with wafte, are put with the refufe of the garde and poor Tin, which were in the tails of the tye and gounce, and being fent to the ftamping mill, are triturated and pulverifed, fo that all wafte may be cleared from the Tin by fundry ablutions, the fame as are performed in the dreffing of Mine-Tin.

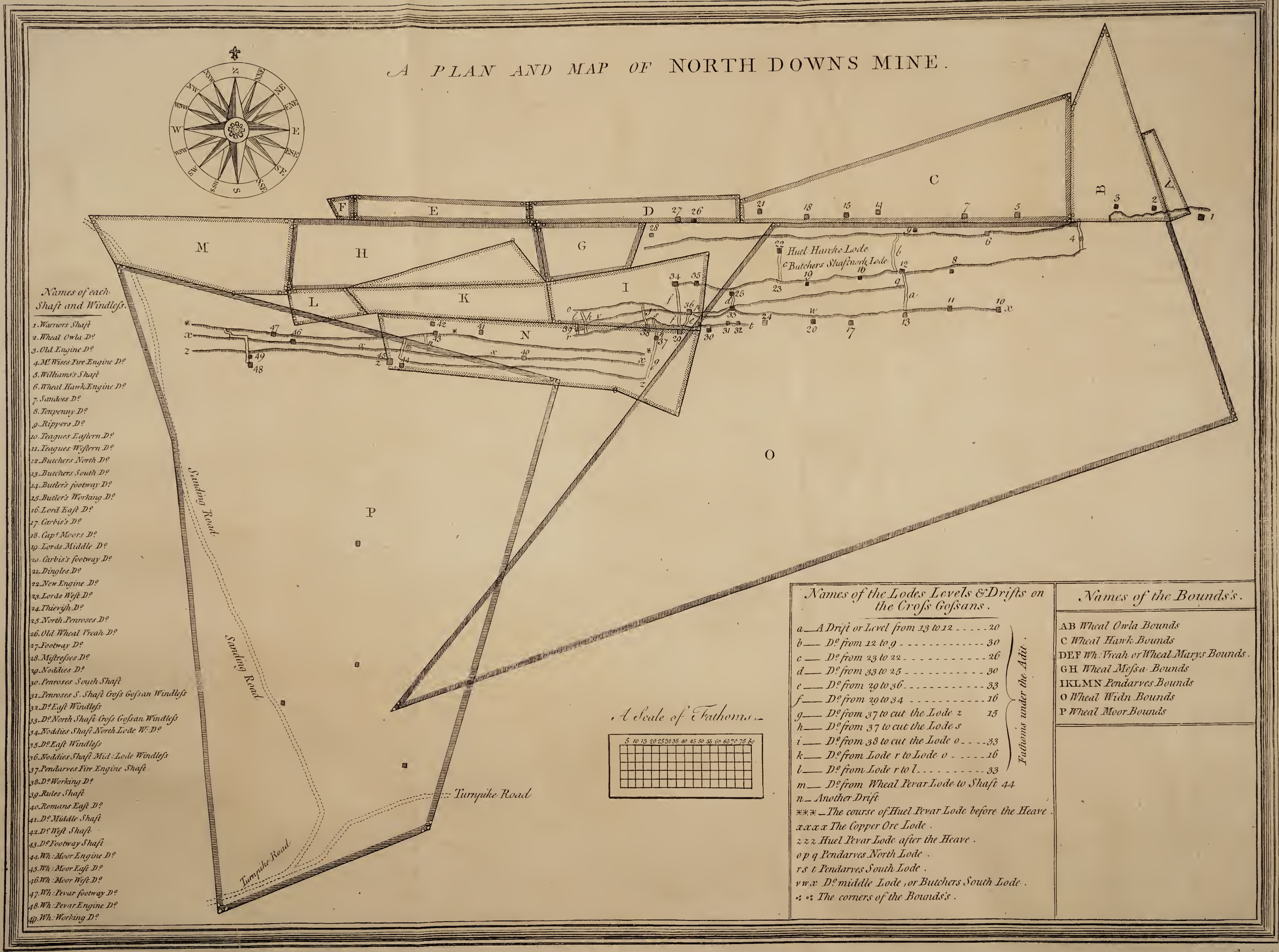
Befides thefe Stream works, we have another fort of them occafioned by the refufe and leavings from the ftamping mills, &c. which are carried by the rivers down to the lower grounds; and

and after ſome years lying and collecting there, yield ſome money to the laborious dreſſers, whom they diſtinguiſh by the name Lappiors, I ſuppoſe from the Corniſh word Lappior, which ſignifying a Dancer, is applied to them, from the boys and girls employed in this work, and moving up and down in the buddles, to ſeparate the Tin from the refuſe, with naked feet like to the ancient Dancers. I have been told, that about ſeventy years back, the low lands and ſands under Perran Arwothall, which are covered almoſt every tide with the ſea, have, on its going off, employed ſome hundreds of poor men, women, and children, incapable of earning their bread by any other means. To return :

Stream Tin being prepared and made ready for blowing with a charcoal fire, is carried to the blaſt furnace, which is called a Blowing-Houſe ; where, formerly, the Tinner might have his Tin blown, paying the owner of the houſe twenty ſhillings for every tide or twelve hours, for which the blower was obliged to deliver to the Tinner, at the enſuing coinage, one hundred groſs weight of white Tin for every three feet, or one hundred and eighty pounds of Stream Tin ſo blown ; which is equal to fourteen pounds of Metal for twenty of Mineral, clear of all expence. Now, that the blowing-houſes are farmed, the Tin is uſually blown and ſold by ſample, as the Mine-Tin is at the reverberatory furnaces.

The furnace itſelf for blowing the Tin, is called the Caſtle, on account of its ſtrength, being of maſſive ſtones cramped together with Iron to endure the united force of fire and air. This fire is made with charcoal excited by two large bellows, which are worked by a water wheel, the ſame as at the Iron forges. They are about eight feet long, and two and a half wide at the broadeſt part. The fire place, or caſtle, is about ſix feet perpendicular, two feet wide in the top part each way, and about fourteen inches in the bottom, all made of moorſtone and clay, well cemented and cramped together. The pipe or noſe of each bellows is fixed ten inches high from the bottom of the caſtle, in a large piece of wrought Iron, called the Hearth-Eye. The Tin and charcoal are laid in the caſtle, ſtratum ſuper ſtratum, in ſuch quantities as are thought proper ; ſo that from eight to twelve hundred weight of Tin, by the conſumption of eighteen to twenty-four ſixty gallon packs of charcoal, may be ſmelted in a tide or twelve hours time. Thoſe bellows are not only uſeful for igniting the charcoal, but they throw in a ſteady and

powerful



Basire sc.

To the Revd. Francis Cole, this Plan of NORTH DOWNS MINE in the Parish of Redruth Cornwall.
Engrav'd at his expence is most gratefully Inscribed by W. Pryce.

powerful air into the caftle; which, at the fame time that it fmelts the Tin, forces it out alfo through a hole at the bottom of the caftle, about four inches high, and one inch and a half wide, into a moorftone trough fix feet and a half high, and one foot wide, called the Float; whence it is laded into leffer troughs or moulds, each of which contains about three hundred of Metal, called Slabs, Blocks, or Pieces of Tin, in which fize and form it is fold in every market in Europe; and on account of its fuperior quality is known by the name of Grain Tin, which brought a price formerly of feven fhillings, that is further advanced, the laft two or three years, to ten or twelve fhillings ℔ hundred more than Mine Tin is fold for, becaufe it is fmelted from a pure Mineral by a charcoal fire; whereas Mine Tin is ufually corrupted with fome portion of Mundick, and other Minerals, and is always fmelted with a bituminous fire, which communicates a harfh fulphureous injurious quality to the Metal.

CHAP. III.

Of Bounds and the Manner of taking a Set or Grant for Mining; of Sinking of Shafts, Driving of Adits, Digging and Raifing of Ores, and Working the Mines, &c.

PREVIOUS to the working of a Tin Mine, a Grant or liberty muft firft be procured from the lord of the foil, if it is in Several and not bounded; but if the ground is in Waftrel and bounded, no liberty from the lord is neceffary, but from the Bounder only. Thefe Bounds are limited portions or pieces of land, enjoyed by the owners of them in refpect of Tin only; and by virtue of an ancient prefcription or liberty for encouragement to the Tinners. They are limited by holes cut in the turf, and the foil turned back upon the turf which is cut, in form of a mole hill, and directly facing another of the like kind; thefe are called Corners of the Bounds, containing fometimes an acre, fometimes more, and often lefs. By drawing ftraight lines from the Corners, the extent of thefe Bounds is determined; in like manner as in geometry, by drawing ftraight lines from three or four points, the extent of a triangular or quadrangular fuperficies is known.

 By

By obferving the legal forms, if the land is neither bounded nor inclofed, but a Waftrel or common, then may any one mark out Bounds there, and fearch for Tin; but, in compliance with the Stannary laws, whoever intends to cut a Tin Bounds muft firft give three months notice of his intention in the Stannary court, and to the lord, for him to fhew caufe why it fhall not be done. By this procedure, the lord is advertifed of a certain lofs to himfelf, whence he prefents an inftrument, praying for liberty and enrolment of fuch Bounds within that Stannary, to his own behoof and benefit; whereby it is pretty clear, that new Bounds are at this day very feldom cut, to which the late gentlemen Stannators no doubt had an eye; becaufe it is no uncommon thing for Bounders who have no title to any part of an eftate above-ground, to grant fets for Tin without the leaft exception in favour of the Lord whofe eftate on the green fide is oftentimes damaged by the deftruction of the foil and the levelling of his fences, and fo forth. The damage, however, is fometimes little to the lord of the foil, who has a fifteenth part of all that rifes, which is fome compenfation for his lofs.

It may be very difficult to afcertain the precife date when Bounds firft commenced; but by confulting fome manufcripts which were lent me by Francis Gregor, Efq; of Trewarthenick, whofe father had been an able and upright vice-warden of our Stannaries, I obferve that the Tinners wrought for their Tin by cuftom, until the 33d of Edward the firft, which was fixty-four years after the Jews were banifhed, when they procured their charter, which was obtained at the follicitation of the lords of Trethewy, Bofwithgy, Treverbyn, Prideaux, Trenans, Auftell, Tremedry, Tregarrick, and Milliack, who obliged their lands to pay affent, and do fervice to the law courts erected by the charter. I elfewhere find by fome manufcript papers of John Cooke, Efq; one of the Stannators for Blackmore, 11th of Charles the firft, "That by occafion of certain difputes, "and the Tynners having greate profitts by their Tynn wrought "from time to time by cuftom, untill the 33d year of king "Edward the firft, A. D. 1305; it was then thought good for "the Tynners to procure by charter from the prince, freely to "grante unto them libertye to digg and fearch for Tynn in any "place where Tynn mighte be found; and a court to deter-"mine all matters and caufes between Tynners." Accordingly I find this liberty expreffly granted in the faid charter, which fays, "We have granted alfo to the Tynners, that they may "digge Tynn and turf for the melting of the Tynn, every

" where in our lands, moores, and waftes ; and of all other " perfons whatfoever, in the county aforefaid." Mr. Beare alfo, in his Bayliff of Blackmore a manufcript of ancient note, in his difcourfe upon what the Tynners did before the charter was granted, fays, " That they always ufed to worke, and fearch " for Tynn in wafterall grounds, and alfo in the prince's " Severall, where any Tynne mighte be gotten ; having likewife " libertye to digge, mine, fearch, make Shafts, pitch Bounds ; " and for Tynne to worke in places of their moft advantages : " excepting only fanctuary grounde, church yards, mills, back " houfes, and gardens ; paying only to the prince or lord of " the foyle, the fifteenth part to and for the toll of their " Tynn."

The fum of all the intelligence I can procure, inclines me to judge, that all Tin was at firft the poffeffionary right of him who had the government of the county, and from whom the liberty was granted, (or from the king) immediately to the fearcher. (Plow. Com. Pearce's Stannary Laws ; Sir John Doddridge.)

Without determining when a cuftom of that kind commenced, it is very natural to fuppofe, that thofe grants were limited and circumfcribed within certain Bounds, beyond which, as at this day, the fearchers dared not to pafs. The acquifition of this valuable property, could not admit of its being in common ; but under certain limits, and prefcriptive forms, it muft have been kept feparate and divided between the fundry proprietors ; in order that each perfon might know and preferve his own property. Whatever modes of partition the moderns might have thought of, there yet feems none more fimple and decifive than thofe here-defcribed, which have exifted from their firft adoption to the prefent hour. Notwithftanding this, by the negligence of fome owners of Bounds, the knavery of others, and the glorious uncertainty and chicane of the law, no Stannary affairs are fo fertile of wrangles and difputes as thofe which relate to Tin Bounds.

The firft inftitution of thofe cuftomary tenures, for the encouragement of fearching for Tin, was laudable and wife ; but the late increafe of Tin and difcovery of Lodes, together with the prefent improvements in Mining, very much diminifh the neceffity of this kind of encouragement. On the contrary, from very

very good reafons I can affert, it would be well for this country in general, if Tin Bounds were totally obliterated.

To preferve the right of a Bounds, it ought to be renewed once every year, which is performed in different Bounds on different faints days, as St. John, St. Peter, St. Paul, &c. by the fervant called the Tollur, the Renewer, or the Bounder, who cuts out a turf from each hole or corner, which he places upon the top of the little bank formed by the turfs already laid there, and declares the renewal to be on the behalf of fuch perfon or perfons, the Bounds owners; from whence he generally goes to fome houfe of entertainment, and takes a dinner, and other refrefhment, in order to celebrate and commemorate that annual renewing day.

In Several, no man can fearch for Tin without leave firft obtained from the lord of the foil, who, when a Mine is found, may work it himfelf, or affociate partners, or fet it out at a farm certain, or leave it unwrought at his pleafure. In Waftrel, it is lawful for the bounder, or any other perfon having liberty from him, to dig and fearch for Tin, provided that he acknowledges the lord's right, by fharing out unto him a fifteenth part of the whole. Then it is lawful for the Bounder to take out one-twelfth, or in fome places by peculiar cuftom one-tenth of the remainder. Tinners may drive an Adit through others Bounds without their liberty, only as a paffage for their water; but if they break Tin or difcover a Lode in their drift or finking of Shafts, they have no benefit of the faid Tin or Lode, but fhall leave it wholly to the owners of the Bounds within which it is.

The ufual grant for Tin where it is not bounded, is the fame as for Copper; and the acknowledgment, Difh, or Dues paid to the lord, is commonly one-fixth, feventh, eighth, ninth, even to one-twelfth, or lefs under fome peculiar circumftances; only that the dues for Copper are payable in money, and for Tin in the Stone or Mineral Ore, and fometimes in white Tin or Metal. This grant by leafe, is called a Set for Tin or Copper, and runs for one and twenty years certain. But a Set of a Bounds for Tin, though verbal, is perpetual, and never ends while it is wrought according to the laws and cuftoms of the Stannaries; that is, if the Tinner has been in quiet poffeffion for the fpace of one year and a day, he may ftill keep his holding at five fhillings expence annually, laid out upon the premifes. This

is

is a very injudicious indulgence, and it is an injurious licence for the benefit of the Bounds owners. I can anfwer for the truth of this, and fo can almoft every other Bounds owner in the county; it being no rare thing for a Tinner to keep poffeffion of a Bounds Set, like the dog in the manger.

I do not fuppofe the prefent methods for working of Tin Mines, by deep Shafts, and by Driving and Stopeing under the firm ground, has been practifed more than three hundred years paft. Prior to thofe means for raifing of Tin, they wrought a Vein from the bryle to the depth of eight or ten fathoms, all open to grafs, very much like the foffe of an intrenchment. This was performed by meer dint of labour, when men worked for one-third of the wages they now have. By that method they had no ufe for foreign timber, neither were they acquainted with the ufe of hemp and gunpowder.

This foffe they call a Coffin, which they laid open feveral fathoms in length eaft and weft, and raifed the Tin-ftuff on Shammels, plots, or ftages, fix feet high from each other, till it came to grafs. Thofe Shammels, in my apprehenfion, might have been of three kinds, yet all anfwering the fame end. Firft, they funk a pit one fathom in depth and two or three fathoms in length, to the eaft and to the weft, of the middle part of the Lode difcovered; then they fquared out another fuch piece of the Lode for one or two fathoms in length as before, at the fame time others were ftill finking the firft or deepeft ground funk, in like manner; they next went on and opened another piece of ground each way from the top as before, while others again were ftill finking in the laft and in the deepeft part likewife: in this manner they proceeded ftep after ftep; from which notion arifes the modern method of Stopeing the bottoms under-ground. Thus they continued finking from Caft to Caft, that is, as high as a man can conveniently throw up the Tin-ftuff with a fhovel, till they found the Lode became either too deep for hand work, too fmall in fize, very poor in quality, or too far inclined from its underlie for their perpendicular workings. Secondly, if the Lode was bunchy, or richer in one part than another, they only laid open and funk upon it, perhaps in fmall pitches not more in length than one of the Stopes or Shammels before defcribed. The fhortnefs of fuch a piece of Lode would not admit of their finking Stope after Stope; it was then natural and eafy for them, to fquare out a Shammel on one fide or wall of their Lode, and fo to make a landing place

 for

for their Tin-ſtuff caſt after caſt. Thirdly, if the Lode was wide, and the walls of it, and the adjoining country, very hard ſolid ground, it was in ſuch caſe more eaſy for them to make Shammels or ſtages, with ſuch timber, &c. as was cheapeſt and neareſt at hand.

This, with Streaming, I take to be the plain ſimple ſtate of Mining in general, three centuries ago; and from hence is derived the cuſtom of Shammeling both above and under-ground at this time; for in the clearing of Attle, (Deads) or filling the Kibble with Ore, the Miners prefer a Shammel, which is a ſtage of boards, for the more light and eaſy uſe of their ſhovels.

But as this manner of working was irreconcileable with the diſcovery and raiſing any Tin-ſtuff below a certain very ſhallow depth, it became neceſſary to contrive ſome other way to follow downwards the inviting rich ſtones of Tin ſome Lodes produced. The method of Shammeling, even in thoſe moderate times, has been expenſive, where a very ſmall Lode of Tin occurred in a hard country. To remove a denſe hard ſtratum of rocky overburden, muſt be very fatiguing and perplexing; therefore they found it moſt adviſeable to ſink Shafts down upon the Lode, to cut it at ſome depth, and then to Drive and Stope eaſt and weſt upon the courſe of the Lode: in time, no doubt, ſuch improvements preſented, as rendered that the cheapeſt and moſt eſtabliſhed cuſtom of Mining.

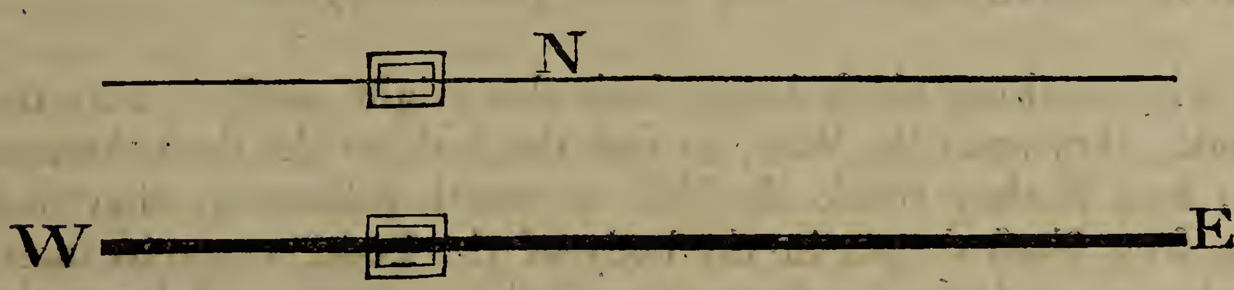
The ſpeculative reader may be apt to imagine, that we can trace, and diſtinguiſh, the different advancements which have been made in Mining, by the depth and proportion of old Shafts, &c. But it is not ſo; for Shafts, and other workings of the Mines, depend upon the ſame, and yet different contingencies, in one and the ſame Mine. It is very likely, that a hundred years ſince, a Shaft would not be ſunk in a certain place but fifteen fathoms deep, from the quantity of water; where it now may be done beyond fifty fathoms, without a drop. The reaſon of this is not becauſe the ſkill of the preſent occupiers is greater than that of the former; but becauſe the adjoining ſtrata or country is Bled, as we call it, by Adits, and ſundry other drifts and levels, driven through them poſterior to that time.

Having ſhewn how Sets for Tin and Copper are granted, and how Tin was anciently ſought for, at a time, indeed, when

Copper

Copper was as well known to be in Terra incognita, as in Cornwall, we ought to proceed to the difcovery of the Lode: but as this has been defcribed elfewhere, we fhall now fet forth the firft arrangements for working a Mine; in order to which, the principal thing to be thought of is a Shaft to cut the Lode, at twenty or thirty fathoms deep, if it is poffible to be done. Here it is neceffary to form fome judgment of the inclination or underlye of the Lode, before we attempt to fink a Shaft: for inftance, if the Lode underlies to the north about three feet in a fathom, and a Shaft is defigned to come down upon the Lode in twenty fathoms finking, the Miner muft go off north from the back of the Lode full ten fathoms, and there pitch his Shaft; by which means he is certain to cut the Lode in the Shaft about twenty fathoms deep; becaufe for every fathom the Lode defcends in a perpendicular line, it is alfo gone three feet to the north of the perpendicular.

But to render this the more confpicuous, let the line E W reprefent the back or furface of a Lode pointing eaft and weft, and whofe underlie is north: by finking a Shaft upon this back, it will foon be deferted by the Lode, which is gone further north three feet for every fathom that is funk upon that line; fo that when the Lode is twenty fathoms deep, it muft be gone north to the imaginary line N, where another Shaft muft be funk to cut the Lode at that depth.



A proper working Shaft, upon which a Whym may be erected if neceffary, fhould be fix feet long and four feet wide, or more where large water barrels may be wanted; and the harder the ground is, the longer and wider the Shaft ought to be, that the men may have the more liberty to work and break it, the area of a large fhaft being more eafy to rip up where the ground is hardeft, than of a fmall one where it is more confined together, and breaks in fhreds of ftone, &c.

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In many parts of the Mining diſtrict, the north or the ſouth channel appears to full view; and it is a maxim among the Miners, when they erect their windlaſs upon a Shaft, to place it true to the horizon; in order to which they make an obſervation in a line to the fartheſt diſtance they can ſee, which is always the ſame height as the eye of the obſerver, either upon the higheſt hill, or with the edge of the water.

A Shaft that is deſigned for a water engine, may ſerve, if it is of the ſize of the largeſt working Shaft; but a fire engine Shaft ought to be, at leaſt, nine feet ſquare, or ten feet by eight, or in fact to contain three Shafts in one, which muſt be partitioned into three compartments, all the way down from graſs to the deepeſt bottom of the Mine. One half is divided for the pumps and engine work; three feet in length of the other is proportioned for a foot way, to go down and rectify the pumps when amiſs; and the remainder is divided alſo by a partition of boards, for a whym Shaft to draw the Deads and Ore from the Sump of the Mine. If the ground is hard and very wet, or the water very quick upon the men in ſinking, there ought to be eight men employed to ſink a working Shaft; that is, two men in a corps of every ſix hours; and in a fire engine Shaft, there ſhould be ſixteen employed in the ſame manner: but if the ground is tender, and there is no hindrance by water, ſix men in the firſt, divided into three corps every eight hours, are reckoned ſufficient; yet I have known four and twenty men put to ſink an engine Shaft upon a great emergency.

The working Shaft being ſunk downright until it cuts the Lode, they open the Vein, or ſink the body of the ſhaft through it; and if they think the Vein is worth following, they ſink the ſame Shaft deeper in the body of the Lode, upon its inclination or underlie; whence the Shaft becomes, and bears the name of, an Underlier: at the ſame time they turn houſe, as they call it, from the bottom of their perpendicular, or from the top or beginning of the underlie. So that when the Lode is well impregnated, they turn houſe by driving or working horizontally on the courſe of the Vein, either to the eaſt or to the weſt, or both, as they find it moſt likely to anſwer their expectations, in order to make a fuller trial and diſcovery. Where the Lode anſwers well in thus driving upon it, they continue to do ſo, till they are prevented by want of air; or till the end of their workings is too far from the Shaft, and the expence of rolling back the ſtuff to the Shaft is great and incommodious;

incommodious; then it is proper to put down another Shaft as before defcribed, or more to the north, becaufe it will be more convenient, the longer it continues downright. Mean while, they are mindful to fink their firft Shaft in order that they may work away the Lode from thence in Stopes, and have a little Sump or pit in that place as a bafon for receiving the water of the Lode, whence they difcharge it to grafs by the eafieft method they can devife: for moft Lodes have ftreams of water running through them; and when they are found dry, it feems to be owing to the waters having been forced to change their courfe, either becaufe the Lode has ftopped up the old paffages, or becaufe fome new or more eafy ones are made, whereby the Lode and ftrata adjacent to it are bleeded as we term it. However, they are often hindered from going down deep enough to find any great quantity of Ore, by the burden of water that moft Veins abound with; therefore, if the Mine is not encouraging, they give over any further purfuit; but if it feems likely to prove well, and the Lode lies in an afcending ground, they quit the Vein for the prefent, and go down to the moft convenient place in the valley, and from thence they bring a Trench, Drain, or Conduit, which they call an Adit, Tye, or Level; and fo they work and drive this paffage through the hill in a right line to the Lode, with very little lofs of the level they began from.

Where the Adit is intended only for the fake of unwatering one particular Vein, it is frequently advifeable to bring it home on the courfe of it, if the fituation of the ground will admit, becaufe this is a continual trial of it at that depth: yet, if there are many Lodes not far afunder, an Adit brought home athwart them may fometimes be preferable, if it can be conveniently complied with; for the fituation of the ground muft be well confidered, to judge how to drive home the moft fhort, deep, fpeedy, and cheap Adit, with the moft probable fuccefs.

If the hill takes its courfe eaft and weft a confiderable length, and the difcovery of the Vein is very far from a valley at either end of the hill, there may be no choice in the matter; for the fhorteft and cheapeft Adit will of courfe be driven from the north or fouth, unlefs moorftone or ireftone ftrata intervene. It then behoves the adventurers to feek for a Crofs-Goffan, where it lies convenient in diftance from the difcovery, to bring home the Adit in; and provided the Goffan does not exceed three feet in width, it is reckoned very favourable, becaufe the

 Adit

Adit may be wrought through the body of it, without the ufe of timber and boards to fupport and keep it up. On the contrary, moft Crofs-Goffans are too wide to break down the whole breadth for an Adit; and therefore they drive on the eaftern or weftern fide of it, which ever is moft to their liking, and at the fame time break down a fmall thicknefs of its contiguous wall, fo that they are fure to cut all Veins, and branches of metallick Veins, in their paffage to the Mine; by which means, as in driving levels acrofs the country out of thofe crofs-courfes, many more valuable Lodes have been difcovered, than thofe they were driving to unwater. Neverthelefs that fide of the Adit which is in the body of the Goffan, muft be braced up, and bound with boards, as muft likewife its back or top, otherwife the hinder part of the level may fall in and occafion a choak in it. Yet there are fome few Goffans that will ftand without any fupport.

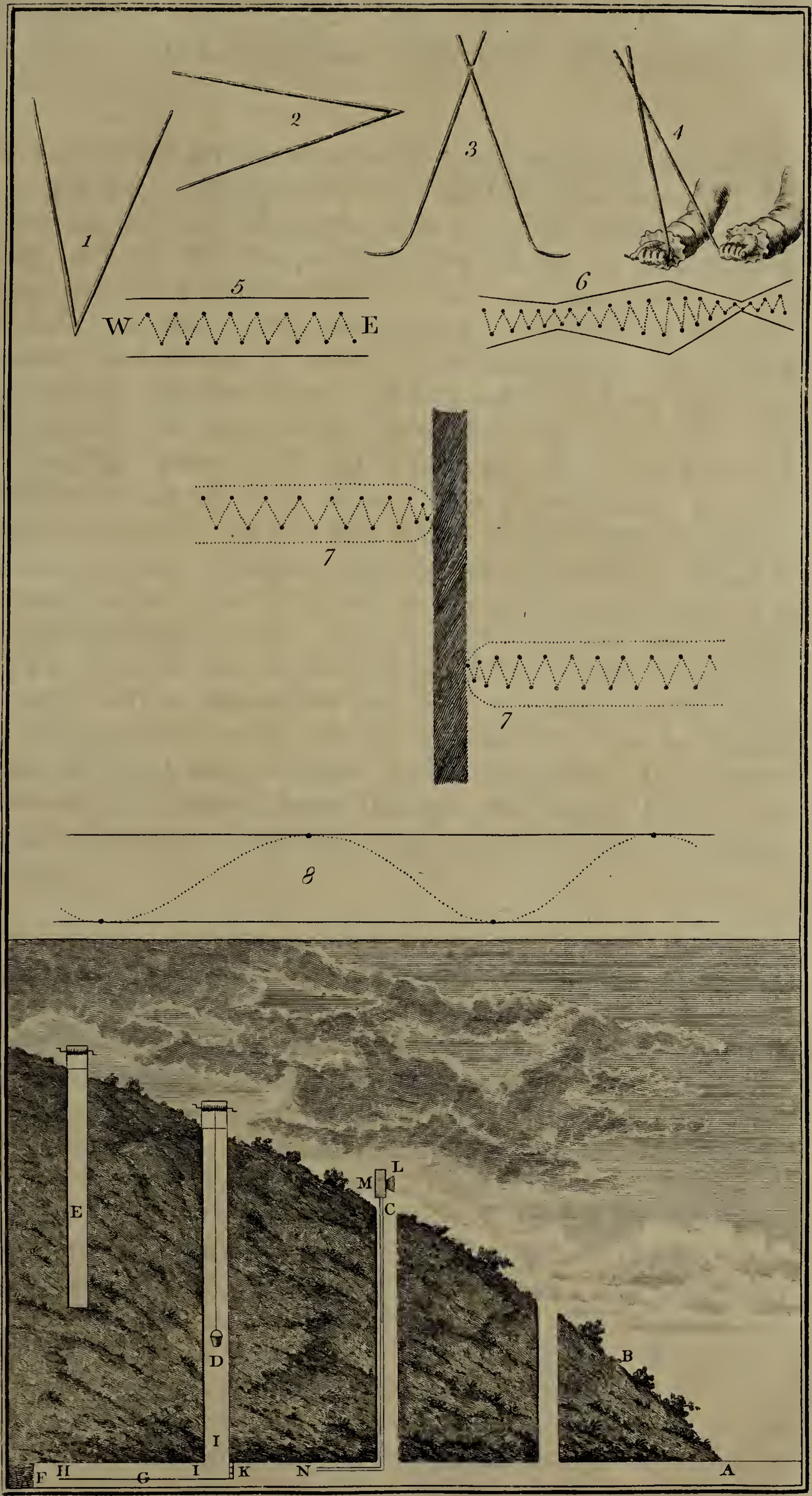
Thefe Adits are commonly fix feet high and about two feet and a half wide, fo that there may be room enough both in height and breadth to work in them; and alfo room to roll back the broken deads in a wheel-barrow: but if the ground or rock be very hard, the Adit ought to be more fpacious or large each way, to give the greater liberty or room to work and break the ftone. An Adit requires four men to work it conftantly by day and night, and a boy or two to roll back the broken work, if they break it very faft.

The neceffity for Shafts in driving an Adit, occurs very frequently to fupply the workmen with air, and for the convenience of winding up the deads. Where the country is very hard, the Shafts fhould be forty fathoms diftant from each other; and where the ground is feafible or moderately tender, they may be twenty fathoms diftant; but in this, as in all other parts of Mining, the adventurers muft be ruled by the varieties of place and other circumftances. An Adit Shaft fhould be fix feet long and three feet broad, which generally employs fix men to work it day and night.

When the Miners want air by being a great way under-ground, and cannot conveniently put down a new Shaft; then, if the Adit be high enough, they lay boards on the bottom of the Adit, from their laft Shaft along to the Adit end, and fo ftop them down clofely with clay or earth, by which contrivance, called a

Saller,

Plate 2d.



To Sir William Molesworth, of Pencarrow in the County of CORNWALL, *Baronet.* *This Plate of the* Virgula Divinatoria, &c. *engraved at his expence, is most gratefully Inscribed, by*

Wm. Pryce.

Saller, the boards being hollow underneath, air is conveyed to the workmen.

To make thefe matters clear with regard to driving and Sallering an Adit, let us fuppofe A to be the loft flovan or tail of the Adit, the level from which the Adit was firft driven, all open to grafs, till it took into the fide of the hill B. A little further on they put down an Adit Shaft for air, or conveyance of the deads from the Adit. The next Shaft C, was funk for the fame purpofes; and fo was D, which is reprefented as the prefent working Shaft, for the other Shaft E is not funk down upon the Adit end F. For want of the Shaft E being holed upon the end F, the air is very clofe and fuffocating; nay, the Adit end muft be deferted for want of air. To remedy this, they go behind the fhaft D, and put in a Saller, or clofe ftage of boards G, about one foot high from the bottom of the Adit, which is continued within five or fix feet to the end at H, where it is open and difcharges the air back through the Adit and up the Shaft I I, becaufe that is totally ftopped by an exceeding clofe door at K. There is another way of forcing down air by an air pipe, as at the Shaft C; the top of which L, can be turned towards the wind when it blows from any quarter, and receives the air which is forced down through the funnel M into the Adit at N, whence it circulates back again through the former workings.

This air pipe is feldom ufed in Adits, becaufe the Saller is more cheap and eafy, the difference of expence in the air pipe being confiderable where an Adit Shaft is thirty or forty fathoms deep; befides, the Saller under the workmen's feet is lefs incommodious, than the funnel over their heads: neverthelefs, this air pipe is of indifpenfable ufe in the finking a Shaft that is void of circulation of good air, and it is feldom that a Shaft of forty fathoms depth can be funk without an air pipe all the way down from grafs, provided the Shaft has no communication, by drift or Gunnies, with fome other parts of the workings. It muft be noted, that great care is requifite to ftop clofe every crevice of the air pipe, or the Saller, with clay or pitch and oakum, fo that not a breath of air fhall efcape. The Saller, indeed, may be covered clofe with turf and earth laid all round and upon it; whereby no air can have vent but at its proper place H. By duly attending to this circumftance, an Adit may be driven beyond one hundred and fifty fathoms, before a Shaft need be funk down upon it. This is an affair of no mean

confequence,

confequence, where a Shaft muft be funk very deep in exceeding hard ground.

Sir Robert Moray, in the Philofophical Tranfactions No. 5, has communicated a method practifed at Liege for driving of Adits without air Shafts, by erecting a chimney thirty feet high, at the tail or loft flovan of the Adit, from whence an air pipe is continued through the Adit; whereby all foul air at that place is invited or drawn, by the fire, from the working part or end of the Adit unto the chimney, where it enters under the grate filled with live coal and fufpended in the middle of the chimney. This may ferve, where the air is rendered noxious by fulphureous or vitriolick effluvia, to carry it off by the funnel into the chimney; but in our Adits we have no vapourous fumes to difcharge. With us it is an abfolute want of air, or circulation thereof; fo that our relief is only acquired by pouring in a frefh current of air, and continuing the circulation as freely and uniformly as poffible.

The numerous little eminencies that compofe the face of our country, where the Mines are fituate, afford us great advantages for Adits to unwater the Veins contained in them. Though we feldom fee an Adit half a mile in length, there are two or three of three times that length, and thofe are the longeft I know of. At Friberg in Saxony, they have very extraordinary works of this kind, particularly that called the Prince's Level, one of the greateft works in thofe parts, confidering the time, labour, and expence neceffary to work a paffage under-ground, for about five Englifh miles in length.

The labour and expence of driving this level, muft have been great and tedious, where it happened in fuch exceeding hard ground as we fometimes meet with here: for although I have known an Adit end driven feveral fathoms at four fhillings a fathom in Pot Grouan, that is, foft grouan; yet I have paid twelve guineas for the fame Adit, that we have driven many fcore fathoms for lefs than one; fo various and uncertain are the ftrata of the earth in thefe parts. The greateft expence for the ground difcovered, that I ever heard of in driving an Adit, was in the old Pool, two miles off, where Mr. Baffet paid five and thirty pounds ℔ fathom for the driving of feveral fathoms, through an Ireftone ftratum; which great price anfwered fo badly for the contractors, that they were very much injured by the undertaking. The moft defirable ground to drive an Adit in, in, where it cannot be brought home upon the Lode itself, or a crofs-courfe, is a tender feafible Killas of eighteen fhillings ℔ fathom. This ground needs no timber to fupport it, and can be fpeedily fpent or worked at the rate of eight or ten fathoms monthly.

If an Adit is fet by the fathom, and the ground proves hard, the workmen are often regardlefs of driving in a direct ftraight line, and are apt to drive irregularly for the advantage of working in the faireft ground; but this makes a reckoning of more fathoms to the adventurers difadvantage, than they ought in juftice to be accountable for; therefore it is the moft prudent method, when an Adit is fet by the fathom, to agree, that the meafurement fhall be on the grafs or furface, becaufe then if the workmen drive out of the way it will be their own lofs.

In bringing home thefe levels, the natives of Cornwall never confider the expence fo much as the time it may be performed in; indeed, it is an axiom in Mining, that the quicker an Adit is driven, the lefs muft be the expence. Some levels have taken thirty years to complete them; and I have been concerned in one that took feventeen years to bring it home to the Mine. Yet notwithftanding all difadvantages, fundry levels have been carried acrofs as meer feeking adventures, for the fake of difcovery, without being bound for any particular Mine; and fome of them, by patience and perfeverance, have amply rewarded the enterprize.

I muft allow that fuch adventures are very laudable; for if a level forms an horizontal acute angle with the perpendicular fection of the fummit of a hill, at the charge of three thoufand pounds in fifteen years driving, though without the fuccefs defired, it is likely to prove an ufeful undertaking for pofterity, who may reap the advantage of it, when they want levels to unwater veins that may be difcovered in other parts of the hill. The expence of an adit is flow and fmall; therefore it is eafily borne. Two or three hundred pounds a year in driving an Adit, is fcarcely felt by eight or ten perfons, than whom feldom fewer are concerned; and this too upon the chance of finding a vein, or veins, that may throw up an amazing profit prefently after difcovery, by an advantage in the very means of difcovery itfelf.

An Adit being driven home to the Mine, the water feldom fails of draining and falling into it; fo that the Lode is unwatered as deep as the level of the Adit, to which depth, or yet a greater, the men are at liberty to fink and drive on the Lode if they think proper.

With all the fkill and adroitnefs of our Miners, they cannot go any confiderable depth below the Adit, before they muft have recourfe to fome contrivance, for clearing the water from their workings. The hand pump, and the force pump, will do well for fmall depths, and are neceffary in the firft finkings into the Lode, before the Stopes can proceed. Next to thefe, the water is drawn to Adit by fmall water barrels; but if the water exceeds a certain number of barrels, in a core of fix or eight hours, they give over drawing by hand, and erect a Whym, which is a kind of horfe engine to draw water or work, and fometimes both, efpecially in the infancy of a Mine. A common Whym which ferves both purpofes, confifts of a perpendicular axis, whereon a large hollow cylinder of timber turns, called the Cage, round which the rope winds horizontally, being directed down the Mine by two pullies fixed in what are termed Puppet Heads over the mouth of the Shaft: this axis has a tranfverfe beam, called the Arm infixed; at the end of which are placed two horfes that go round upon a platform named the Whym-round, and draw more or lefs according to the number of their circumvolutions in any given time, the largenefs of the barrels, and the depth the Whym is to draw. For drawing of water, this engine can only work in a perpendicular Shaft; but for winding of work or deads, it can be ufed to draw upon the underlie of the Lode.

Another water engine is the Rag and Chain, which confifts of an iron chain with knobs of cloth ftiffened and fenced with leather, feldom more than nine feet afunder: the chain is turned round by a wheel of two or three feet diameter, furnifhed with iron fpikes, to inclofe and keep fteady the chain, fo that it may rife through a wooden pump of three, four, or five inches bore, and from twelve to twenty-two feet long, and by means of the leather knobs bring up with it a ftream of water anfwerable to the diameter of the pump, and in quantity according to the circumvolutions of the wheel in any given time. Several of thefe pumps may be placed parallel upon different Stulls, Sallers, or Stages of the Mine, and are ufually worked by hand like thofe in our navy. The men work at it naked excepting their loofe

loofe trowfers, and fuffer much in their health and ftrength from the violence of the labour, which is fo great that I have been witnefs to the lofs of many lives by it.

A rag and chain pump of four inches diameter, requires five or fix frefh men, every fix hours, to draw twenty feet deep; and to keep it conftantly going, twenty or twenty-four men muft be employed monthly, at forty or fifty fhillings each man. The monthly charge of one of thefe engines cannot be lefs than fifty or fixty pounds; and they are now pretty generally laid afide on account of the great expence, and the deftruction of the men. Neverthelefs the motion of the rag and chain, when it is conftant, is fo quick, that it will difcharge a quantity of water, even exceeding that of a wheel and bob engine, whofe pump is 10 inches bore; and it may be ufefully applied to draw water from fundry parts, fuch as dippas or little pits of a Mine, which have no communication with other aqueducts to the grand machinery for delivering of the water to Adit.

Where the rag and chain pumps are unequal to the work, and too chargeable for the Mine to repay, they may have recourfe to the whym again; and inftead of drawing with fixty gallon barrels as at firft, they may put in larger ones to the amount of 120 gallons in each barrel drawn by the additional help of two horfes more. This draught muft be within twenty fathoms, and not lefs than two barrels a minute, to be worth the charge.

The water wheel with bobs, is yet a more effectual engine; whofe power is anfwerable to the diameter of the wheel and the fweep of the cranks fixed in the extremities of the axis. Over them two large bobs are hung upon brafs center gudgeons fupported by a ftrong frame of timber, and rife and fall according to the diameter of the fweep of the cranks, or of the circle they defcribe. To each crank is fixed a ftraight half fplit of balk timber, that communicates with each bob above: at the other hand or nofe of the bob over the Shaft, a large iron chain is pendent, faftened to a perpendicular rod of timber that works a pifton in an iron or brafs hollow cylinder, called the Working Piece: the quantity of water exhaufted, will be in proportion to the bore of the working piece, and the number of times which the embolus works up and down in a given fpace. The water engine wheel at Cooks Kitchen Mine, is forty-eight feet diameter, and works her tiers of pumps of nine inches bore, which

which being divided into four lifts, draws eighty fathoms under the Adit. If the ftream of water were fufficient to fill the buckets of the wheel, fhe would draw forty fathoms deeper with the fame bore; and I have been well informed, that the power of a forty-eight feet wheel, is equal to the diameter of a forty-feven inch fire engine houfe cylinder: whence this kind of engine is the moft eligible, where grafs water is plenty, and to be had for a fmall rent.

The number of ftamping mills adjacent to the Mines, and the value of water for the various ablutions of Tin and Copper Ores, render every fmall rivulet of fome confiderable confequence to thofe through whofe lands the water happens to flow. Many of our country gentlemen have made great rents of their water courfes, when they have been diverted from their grift mill tenants; and fome of them, without any recompence made to the leffees, have received fifty pounds a month, feveral years, for a fmall mill ftream of water to drive one of thofe engine wheels upon Mines in their own lands.

Happy would it be for the Mining intereft, if our fuperficial ftreams of water were not fo fmall and fcanty; but the fituation of our Mines, which is generally in hilly grounds, and the fhort current of our fprings from their fource to the fea, prevent fuch an accumulation of water, as might be applied to the purpofe of draining the Mines; and of courfe the value of water is the more enhanced. There are very few ftreams, which are fufficient to anfwer the purpofe in fummer, as well as in winter, fo that many engines cannot be worked from May to October; which is a great lofs at that feafon of the year, when men can work longer at grafs, and with more vigour, than they can in fhort days and cold weather. Yet the innumerable Adits driven into the earth, afford tolerable fupplies of water to thofe ftreams, and are of fome importance to the unwatering of the Mines. By the fuperior addrefs of our Miners, the rivulets are often extended many miles to drive an engine; and are then returned as far back again as poffible, to ferve other Mines and ftamping mills; befides, the moifture of our air and fituation, which is directly expofed to the great weftern ocean, as well as to the Britifh and Briftol Channels, caufes abundance of rain, and contributes not a little to fwell our fmall rivers after the autumnal equinox.

But where the ſituation of a Mine will not admit of a water engine, or where the ſtream is inſufficient, the laſt reſource is that moſt uſeful, powerful, and noble machine, the fire engine, of which we have ſeveral that are perhaps the largeſt in the kingdom. It is the moſt admirable curious and compounded machine amongſt all that owe their invention to the diſcoveries of modern philoſophy, and affords the greateſt advantages to mankind. The marquis of Worceſter, in his century of inventions publiſhed in the year 1663, is probably the firſt that propoſed raiſing any great quantities of water by the force of fire converting water into ſteam; but captain Savery was the firſt who erected an engine for this purpoſe in the form we have ſince had them, and which has been lately improved by Mr. Blakey, though not to a degree of power ſufficient to unwater a deep Mine.

Mr. Newcomen, and Mr. J. Cawley, contrived another way to raiſe water by fire, where the ſteam to raiſe the water from the greateſt depths of Mines is not required to be greater than the preſſure of the atmoſphere; and this is the ſtructure of the preſent fire engine, which is now of about ſeventy years ſtanding.

Let us ſuppoſe a pump, or tier of pumps as we ſay, to be twenty-five fathoms deep, whoſe cylindric diameter of its full column of water is ſeven inches and a quarter, and of the weight of 3,000 ℔. Now if the rod of this pump were hung by a chain to the noſe of the lever or bob, h h, as at H; and at the other end, another power were applied, as at L, with a ſuperior force; the pump might be worked, and the water raiſed by that power. It appears, this power cannot be ſupplied by the ſtrength of man, or beaſt; for it will require one hundred men to pull down the bob, each pulling with the force of 30 ℔, and one hundred men to relieve them when weary. But as the pump in a Mine muſt not ſtand ſtill, there ſhould, for ſuch hard labour, be a freſh corps of one hundred men every four hours at leaſt, which would amount to ſix hundred men every twenty-four hours. If we allow horſes, and one horſe equal to five men, there muſt be twenty horſes working at a time, and twenty more to relieve them every four hours, where the draft muſt be ſo conſtant and exceſſive; which will amount to one hundred and twenty horſes every twenty-four hours; and ſo great a number, though leſs expenſive than men, will be found too great for moſt Mines, if it were poſſible to apply them to that ufe. I produce this example, to fhew the prodigious force that is required to draw water in the fmall epitome of a Mine; for the diameter of the pump given, and the depth of twenty-five fathoms, bear the leaft analogy to the depth of our Cornifh Mines, whofe fire engine houfe cylinders are generally from fifty-four to feventy inches diameter. Now allowing 8 ℔ to each fquare inch, clear of friction, in the power of a fire engine houfe cylinder of feventy inches diameter; the number of pounds avoirdupoife within its extent of power to lift up or pull down, are equal to 30,784 ℔. The human power equal to this will require the ftrength of 1,026 men every four hours, or 6,156 men the day and night; or 1,230 horfes. A fixty inch cylinder, alfo, which will lift 22,616 ℔, is equal to 4,518 men, or 900 horfes, every twenty-four hours. Some other power therefore muft be applied; which may be effected as follows. B is a large boiler, whofe water, by the fire under it, is converted into an elaftick fteam. (See plate III) The great cylinder C C is fixed upon it, and communicates with it by the pipe D d; on the lower orifice of which, within the boiler, moves a broad plate, by means of the fteam cock, or regulator E 10, ftopping or opening the paffage to prevent or permit the fteam to pafs into the cylinder, as occafion requires. The diameter of the pipe D is about four inches.

The fteam in the boiler ought always to be a little ftronger than the air, that, when let into the cylinder, it may be a little more than a ballance to the external air, which keeps down the pifton at the bottom d n. The pifton being by this means at liberty, the pump rod will, by its great weight, defcend at the oppofite end to make a ftroke, which is more than double the weight of the pifton, &c. at the other end. The end of the lever at the pump, therefore, will always preponderate and defcend, when the pifton is at liberty. The handle of the fteam cock E 10, being turned towards n, opens a pipe D to let in the fteam; and being turned towards O, it fhuts it out, that no more can enter. The pifton is now raifed towards the top of the cylinder at C, and the cylinder is full of fteam. The lever O 1 muft then be lifted up, to turn, by its teeth, the injecting cock at N, which permits the water, brought from the ciftern g by the pipe g M N, to enter the bottom of the cylinder at n, where it flies up in the form of a fountain, and ftriking againft the bottom of the pifton, the drops, being driven all over the cylinder, will, by their coldnefs, condenfe the fteam into water again, and precipitate it to the bottom of the cylinder.

Mr.

Mr. Beighton made an experiment to determine the rarity of ſteam, and found the content of a certain cylinder of ſteam was 113 gallons; and ſince there were 16 ſtrokes in a minute, therefore $113 \times 16 = 1808$ gallons of ſteam ℘ minute. He alſo obſerved, that the boiler proportioned to that cylinder, required to be ſupplied with water at the rate of five pints ℘ minute: and ſince 282 cubick inches make a gallon, $35\frac{1}{4}$ make a pint, and $5 \times 35\frac{1}{4} = 176\frac{1}{4}$ in five pints: alſo the cubick inches of ſteam are $1808 \times 282 = 509856$; if then we ſay, as $176\frac{1}{4} : 509855 :: 1 : 2893$; or one cubick inch of water is expanded into 2893 inches of ſteam; conſequently the ſteam in the cylinder is reduced to $\frac{1}{2893}$ part, when turned to water by the jet of cold water; and therefore a ſufficient vacuum is made in the cylinder, for the piſton to deſcend, unballanced, by the preſſure of the atmoſphere. The piſton being forced down, raiſes the other end of the lever or bob, and conſequently the box of the pump under-ground, which brings up and diſcharges the water at adit, the ſame as at p. Now this whole operation of opening and ſhutting the ſteam regulator and injection cock, will take up but little more than three ſeconds; and will, therefore, eaſily produce 16 ſtrokes in a minute.

That the ciſtern g may always be ſupplied with water, there is an arch fixed near the arch or noſe of the bob H, from whence another pump rod k, with its box and valve, draws water from the level of the adit in the ſame engine ſhaft, and forces it up the pipe m m m into the ciſtern g, which, therefore, can never want water.

That the leathers of the piſton C may be always ſupple and ſwelled out, ſo as to be conſtantly air tight, a ſmall ſtream of water is ſupplied from the injecting pipe M by the arm Z. On the top of the cylinder is a larger part or cup L, to hold the water that lies on the piſton, leſt it ſhould overflow when the piſton is got to its greateſt height, as at W; at which time, if the cup be too full, the water will run down the pipe V to the waſte well at Y.

The water in the boiler, which waſtes away in ſteam, is ſupplied by a pipe I i about three feet long, going into the boiler a foot below the ſurface of the water. On the top of this pipe is a funnel I, ſupplied by the pipe W with water from the cup of the cylinder, which has the advantage of being always warm, and therefore not apt to check the boiling of the water. That the

the boiler may not have the ſurface of the water too low, which would endanger burſting; or too high, which would not leave room enough for ſteam; there are two gage pipes at G, one going a little below the ſurface of the water when at a proper height, and the other ſtanding a little above it. When every thing is right, the ſtop cock of the ſhort pipe being open, gives only ſteam, and that of the long one water; but, if otherwiſe, both cocks will give ſteam when the ſurface of the water is too low, and both give water when it is too high; and hence the cock which feeds the boiler at I, may be opened to ſuch a degree, as always to keep the ſurface of water to its due height.

The cold water, conſtantly injected into the cylinder to condenſe the ſteam, is carried off by the eduction pipe d T Y, leading from the bottom of the cylinder to the waſte well Y, where going a little under water, it has its end turned up, with a valve Y, to keep the air from preſſing out into the pipe, but permitting the injected water coming the other way to be diſcharged, whereby the cylinder is kept empty.

Leſt the ſteam ſhould grow too ſtrong for the boiler, and burſt it, there is a valve fixed at h, with a perpendicular wire ſtanding up from the middle of it, to put weights of Lead upon, in order to examine the ſtrength of the ſteam puſhing againſt it from within. Thus the ſteam is known to be as ſtrong as the air, if it will raiſe up ſo much weight on the valve, as is at the rate of fifteen pounds to an inch ſquare, becauſe that is the weight of air, nearly, on every ſquare inch. When the ſteam becomes ſtronger than is required, it will lift up the valve, and go out: this valve is called the Puppet-Clack. The ſteam has always a variable ſtrength, yet never one-tenth ſtronger or weaker than common air; for it has been found, that the engine will work well when there is the weight of one pound on each ſquare inch of the valve: this ſhews, that the ſteam is then one-fifteenth part ſtronger than the common air. Now as the height of the feeding pipe, from the funnel F to the ſurface of the water G s, is not above three feet, and three feet and a half of water is one-tenth of the preſſure of the air; if the ſteam were one-tenth part ſtronger than air, it would puſh the water out at E; and ſince it does not, it cannot be ſtronger than air, even in this caſe, where, the regulator being ſhut, it is moſt of all confined. When the regulator is opened, the ſteam gives the piſton a puſh, which raiſes it up a little way; then filling a greater ſpace, it comes

comes to be of the fame ftrength with, and fo a ballance to, the atmofphere: thus the pifton, being at liberty, rifes to the top W. The fteam, now expanded into the whole capacity of the cylinder, is weaker than the air; and would not fupport the pifton, were it not for the greater weight at the other end of the lever, which keeps it up. The fteam, each ftroke, drives the injected water of the preceding ftroke out of the eduction pipe d T Y; and would itfelf follow, and blow out at the valve Y, which is not loaded, if it were ftronger than the air, which it never does. If it were exactly equal to the ftrength of the air, it would juft drive all the water out at Y; but could not follow itfelf, the preffure being equal on each fide the valve by fuppofition. If it be weaker than the air, it will not force all the water out of the pipe at d T Y; but the furface will ftand, fuppofe at T, where the column of water T Y, added to the ftrength of the fteam, is equal to the preffure of the air. When the fteam is one-tenth weaker than the air, the height T Y = three feet and a half. Now, fince the whole perpendicular diftance from d to Y is but four feet, and the fteam always fufficient to expel the water; it is plain, it can never be more than one-tenth part weaker than the air, when weakeft.

There is air in all the water injected; and though that air cannot be taken out or condenfed with the fteam, yet will it precipitate through the fteam to the bottom of the cylinder, as being much heavier: for fteam is to water, as 1 to 2893, in its denfity; but the denfity of air is to that of water, as 1 to 864 nearly; therefore the rarity of fteam is to that of air, as 2893 to 864: the air will, therefore, fall through the fteam to the bottom, and from thence be driven out through a fmall pipe opening into the cup at 4, on which is a valve. Now when the fteam firft rufhes into the cylinder, and is a little ftronger than the outward air, it will force the precipitated air to open the valve at 4, and make its efcape; but the fteam cannot follow, becaufe it is weaker than the outward air, as the pifton gives it room, by afcending, to expand. This valve, from the noife it makes, is called the Snifting-Clack.

Among the great improvements of this engine, we may reckon that contrivance by which the engine itfelf is made to open and fhut the regulator and injection cock, and that more nicely than any perfon attending could poffibly do it. For this purpofe, there is fixed to an arch 12, at a proper diftance from the arch P, a chain, from which hangs a perpendicular piece or working beam Q Q, which comes down quite to the floor, and goes through it in a hole, which it exactly fits. This piece has a long ſlit in it, and ſeveral pin holes and pins, for the movement of ſmall levers deſtined to the ſame office of opening and ſhutting the cocks, after the following manner: between two perpendicular pieces of wood, on each ſide, there is a ſquare iron axis A B (plate III, fig. 2) which has upon it ſeveral iron pieces of the lever kind. The firſt is the piece C E D, called the Y, from its repreſenting that letter, inverted by its two ſhanks E and D; on the upper part is a weight F to be raiſed higher or lower, and fixed, as occaſion requires. This Y is fixed very faſt upon the ſaid iron axis A B.

From the axis hangs a ſort of an iron ſtirrup I K L G, by its two hooks I G, having on the lower part two holes K L, through which paſſes a long iron pin L K, and keyed in the ſame. When this pin is put in, it is alſo paſſed through the two holes, in the ends E N, of the horizontal fork or ſpanner E Q N, joined at its end Q to the handle of the regulator V 10. From Q to O are ſeveral holes, by which the ſaid handle may be fixed to that part of the end which is moſt convenient. Upon this axis A B, is fixed, at right angles to the Y, an handle or lever G 4, which goes on the outſide of the piece Q 2, Q 2, and lies between the pins. Another handle is alſo faſtened upon the ſame axis, viz. H 5, and placed at half a right angle to the former G 4; this paſſes through the ſlit of the piece Q 2, Q 2, lying on one of the pins. Hence we ſee, that when the working beam goes up, its pin in the ſlit lifts up the ſpanner H 5, which turns about the axis ſo faſt as to throw the Y, with its weight F, from C to 6, in which direction it would continue to move, after it had paſſed the perpendicular, were it not prevented by a ſtrap of leather fixed to it at œ, and made faſt at the ends m and n in ſuch a manner as to allow the Y to vibrate backwards and forwards about a quarter of a circle, at equal diſtances, on this ſide and that of the perpendicular.

In the repreſentation we have given, the regulator appears open, its plate T Y being ſhewn on one ſide the pipe S, which joins the cylinder and boiler. The piſton is now up, and alſo the working beam near its greateſt height; the pin in the ſlit has ſo far raiſed the ſpanner H 5, that the weight F on the head of the Y is brought ſo far from n, as to be paſt the perpendicular, and ready to fall over towards m, and, when it does ſo, it will by its ſhank E, with a ſmart blow, ſtrike the iron pin K L, and

and drawing the fork horizontally towards the beam Q, will draw the end 10 of the regulator towards 6, and ſhut it, by ſlipping the plate Y under the holes of the throat pipe S. Immediately after the regulator is ſhut, the beam riſing a little higher, with its pin s on the outſide upon the lower part, lifts up the end k 1 of the handle of the injection cock, and opens it by the turning of the two parts with teeth. The jet immediately making a vacuum, the beam again deſcends, and the pin r depreſſing the handle k 1, ſhuts the injection cock; and the beam continuing to deſcend, the pin p bears down the handle G 4, and throwing back the Y, its ſhank D throws forward the fork N Q, and again opens the regulator to admit freſh ſteam. All the parts now begin afreſh to operate; and thus is the engine moſt wonderfully contrived to work itſelf. After the engine had been made, as above deſcribed, for many years, it received another improvement of very great advantage; and that was, inſtead of feeding the boiler with warm water from the top of the cylinder by the pipe W (fig. 1) above, and F f below, it was ſupplied with the ſcalding hot water which comes out of the eduction pipe d T Y, which now, inſtead of going to the waſte well at Y, was turned into the boiler on the top part; and as the eduction pipe before went out at the ſide of the cylinder, it was now inſerted in the bottom of the ſame: and though the preſſure of ſteam in the boiler, be ſomewhat greater in the cylinder, yet the weight of water in the eduction pipe being added to the force of ſteam in the cylinder, will carry the water down continually, by overcoming the reſiſtance in the boiler. (Martin.)

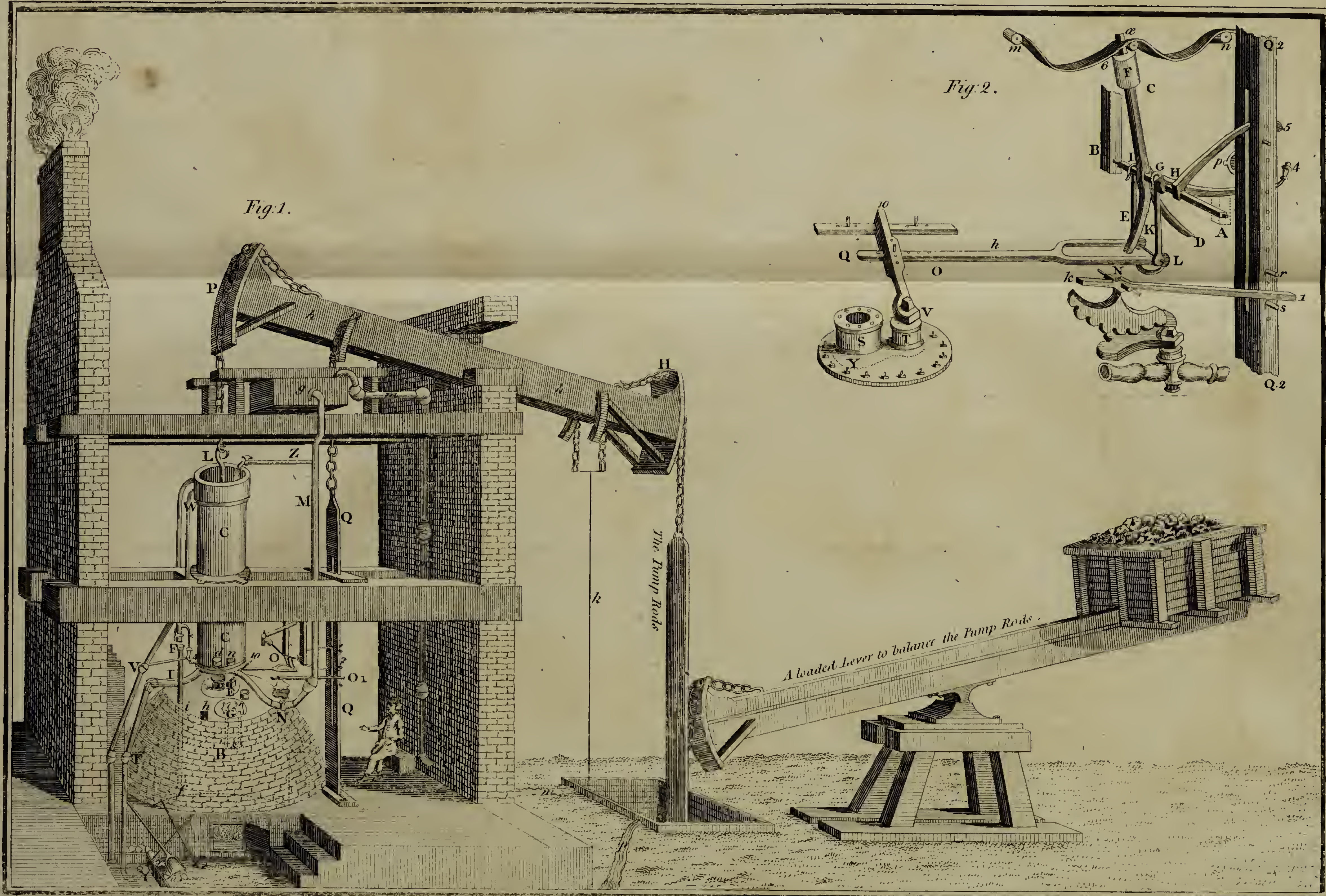
To this deſcription of the fire engine, I ſhall add a moſt curious and uſeful table of the calculation of the power of fire engines for the various diameters of the houſe cylinder, and bore of the pump or pit-barrel, that are capable of raiſing water, at any depth between 2 and 876 fathoms. It was compoſed by Mr. John Nancarrow, jun. and is founded on this principle, that the ale-gallon of 282 cubick inches of water, weighs ten pounds three ounces, avoirdupois; and a ſuperficial ſquare inch is preſſed with the weight of fourteen pounds thirteen ounces of air, when of a mean gravity. But allowing for ſeveral frictions, and to give a conſiderable velocity to the engine, it is found by experience, that no more than eight pounds of preſſure muſt be allowed to an inch ſquare on the piſton in the cylinder, that it may make about ſixteen ſtrokes in a minute, about ſix feet each ſtroke. The uſe of this table is eaſy: if I want to know the power

power of a 60 inch. houſe cylinder, to work a pit-barrel or working piece of 12 inches diameter; I look in the firſt column for the diameter of the houſe cylinder, till I find the No. 60: I then go on in that line to my right, till I come under 12 of the uppermoſt line, which is the diameter of the pit-barrel or working piece, and there find 79, the number of fathoms an engine of that power will draw; that is, a houſe cylinder of 60 inches diameter, will draw with a 12 inch. box, 79 fathoms.

The Mine being ſupplied with a power for the diſcharge of the water, and the adventurers reſolving to prove it at a good depth, they ſink down the engine Shaft continually, or keep it lower than their workings upon the courſe of the Lode, with which it has always a deep communication, that the water may readily flow to the engine pumps, and be drawn to Adit. The bottom of the engine Shaft, while it is deeper than the workings upon the Lode, is properly the Sumph or Sink of the Mine; and this ſhould ever be the caſe, for the Mine to be in regular courſe of working: but when an engine is worked to the full extent of its power, it is common to ſink a Sumph in the Lode itſelf, and draw the water from thence by a force pump (or any more convenient hand machinery) into the engine Shaft; this, however, is ſeldom done unleſs a Mine is ſoon to be ſet idle. If the Lode underlies north, the engine Shaft ought to be at a good diſtance north from the back of the Lode; becauſe, while the engine is drawing the water out of the Shaft, the Lode is ſtill coming nearer to it by every fathom of Lode or ground that is broke away, until at laſt the Lode underlies into the Shaft itſelf; and in proceſs of further ſinking the Mine, the Lode which was before to the ſouth of the Shaft, is gone through to the north of it; ſo that the deeper either of them is ſunk, they are more and more diſtant from each other, and become at laſt very expenſive and incommodious from the unavoidable neceſſity they are under, of continually driving a Croſs-cut, or Drift, from one to the other, that the water may flow into the Sumph for its diſcharge to Adit. This is an evil that cannot be prevented; for, in all deep Mines, their engine Shafts, at laſt, muſt be very diſtant from their Lodes, unleſs the underlie is trifling, and the Lode very little removed from a perpendicular. This Croſs-cut or Drift of Communication is ſometimes very tedious and expenſive, where the ground is hard, the water quick, and the engine almoſt at the extent of its power.

From

Plate 3.



To John Price, of Penzance Esq.r late High Sheriff for the County of CORNWALL.
This Section of a STEAM FIRE ENGINE ENGRAVED at his Expence - is most
Gratefully Inscribed by his Affectionate Kinsman W.m Pryce -

A TABLE, shewing, at one View, the Diameters of the House-Cylinders of Fire-Engines, from 20 to 100 Inches; the Areas, in square Inches, for each respective Diameter; and the Number of Pounds, Avoirdupois, such Cylinders will lift, allowing 8 Pounds to a square Inch clear of Friction: to which are added, the different Depths, in Fathoms, each Cylinder will lift a Column of Water, with Pit-Cylinders or Working-Pieces from 6 to 24 Inches diameter. At the Bottom of these Columns is given the Number of Ale-Gallons lifted in each of these Working-Pieces when the Engine makes a six Feet Stroke; and the last Column to the Right-Hand, shews the Number of Ale-Gallons contained in the whole Tier or Lift of Pumps, answering to House-Cylinders of any Dimensions, from 20 to 200 Inches diameter.

Diameter of the House-Cylinder.	Its Area in square Inches.	Nº of Pounds Avoirdupois allowing 8 lb. to every sq. Inch.	Diameters of the Working-Pieces or Pit-Cylinders.																			
			6 In.	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
			Fath.																			
20	314	2,513	35	26	20	15½	12½	10⅓	8¾	7½	6½	5½	5	4¼	3⅚	3½	3⅙	2⅚	2⅔	2⅓	2⅙	246,4
25	490	3,920	55	40	31	24½	20	16¼	13¾	11¾	10	8¾	7¾	6¾	6⅙	5½	5	4½	4⅙	3¾	3½	384,3
30	706	5,648	79	58	44	35	28	23⅓	19¾	16¾	14½	12¾	11	9¾	8¾	7⅚	7	6½	5⅚	5⅓	5	553,7
35	962	7,696	108	79	60	48	39	32	27	23	20	17	15	13½	12	11	9⅔	8¾	8	7⅓	6¾	754,5
40	1256	10,048	140	103	79	62	50	41	35	30	26	22	20	17	15	14	11½	11¼	10	9½	8¾	985,1
45	1590	12,720	178	131	100	79	64	52	44	38	32	28	25	22	20	18	16	14	13	12	11	1249
50	1963	15,704	218	162	123	97	79	65	54	46	40	35	31	27	24	22	20	18	16	15	14	1539,6
55	2375	19,000	265	196	149	118	96	79	66	56	49	42	37	33	30	26	24	21	20	18	16	1862,7
60	2827	22,616	316	233	178	141	114	94	79	67	58	50	44	39	35	31	28	26	23	21	20	2216,2
65	3318	26,544	371	273	208	165	134	110	93	79	68	59	52	46	41	37	33	30	27	25	23	2602,3
70	3848	30,784	430	316	242	191	155	127	107	91	79	68	60	53	48	43	38	35	32	29	27	3018
75	4417	35,336	495	364	277	220	178	147	123	105	90	79	69	61	55	49	44	40	37	33	31	3464,3
80	5026	40,208	560	413	316	250	202	166	140	119	103	90	79	70	62	56	50	46	42	38	35	3941,9
85	5674	45,392	634	467	356	282	228	188	158	134	116	101	89	79	70	63	57	52	47	43	40	4450,1
90	6361	50,888	710	522	400	316	255	210	177	151	130	113	100	88	79	71	64	58	53	48	44	4989
95	7088	56,704	792	583	446	353	285	235	197	168	145	126	111	98	88	79	71	64	59	54	50	5559,1
100	7854	62,832	876	646	494	390	315	260	218	186	160	140	123	109	97	87	79	71	65	60	55	6160
			7,22	9,82	12,82	16,24	20,04	24,26	28,8	33,88	39,3	45,12	51,37	57,91	64,94	72,39	80,21	88,43	97,06	106,07	115,5	

From the level of the Sumph if it is out of the Lode, or from the Sumph itſelf if it is in the Lode, they turn houſe, and drive on the courſe or body of the Lode to break Ore, or to ſee if they can meet with any in extending the bottom or deepeſt part of the Mine.

Now if the Sumph proves good for Ore, they not only turn houſe, in order to make room and lengthen the bottom of the Mine ; but they likewiſe ſtope or break away the Lode in the following manner : the Sumph being in the Lode, one man with a pick-axe breaks away about two feet of the upper part of the edge of the Sumph or pit, ſtill driving on, on the courſe of the Lode ; and when he makes room, another follows him in like manner, and then others ; ſo that this ſtoping is not unlike the hewing a flight of ſteps in a rock, where each man works away the ſtep above that which he ſtands on.

But if the Ore is not generally plenty in the Lode, and only in uncertain branches, then they often follow theſe branches of Ore, both upwards and downwards. Thoſe ſmall pits they make in digging down after the Ore, and all other pits that are made below in following the Ore, though they are large, are all called Dippas, provided they are not deeper than the Sumph, nor ſunk down to drain the Mine as Sumphs are. But this way of ſinking many Dippas, is apt to diſorder a Mine, and put it out of a regular courſe of working ; and often prevents the diſcovery of Ore, which may lie hid in many places in a Mine, that do not ſeem worth the charge of breaking that part of the Lode which appears poor and barren ; however, if a Mine is on the point of being left off, then it cannot be improper to work in Dippas, where the Ore lies, in order to make the moſt of it.

It often happens that a Lode five or ſix feet wide, may have a branch or leader on one ſide of it, very rich for Tin or Copper, while the reſt of the Lode is very poor and dry. This rich part may be one foot wide, or it may be ſcarcely ſix inches ; ſo that if it is not a working big, or there is not ſufficient for a man to work on Ore excluſive of the barren part, he breaks down, if in an end, or digs up, if under his feet, all the poor part by itſelf, in length, or depth, according as he chuſes, or is directed ; whereby the rich Ore is left ſtanding clean from any other mixture : this he afterwards breaks and keeps by itſelf, whence it is then brought up to cleanſe and dreſs.

 This

This ſeparation or breaking the bad from the good Ore, they call Dyzhuing the leader, or making a Dyzhu; and the good Ore that is thus expoſed, is called a Dyzhu, from the Corniſh Britiſh Dyzhui, to diſcover unto. This method of proceeding is very uſeful, to prevent the more valuable part of the Lode from being mixed promiſcuouſly with the barren part, which would increaſe the charges of dreſſing the Ore, and of conſequence diminiſh its value by the deads and waſte that would neceſſarily be mixed with it if the Lode was broken altogether.

But though the utility of this method muſt be very obvious to the reader, Dizhuing the Lode in whole, is popularly underſtood in the following manner: when the whole Lode is rich, and perhaps not above ſix or twelve inches big, it will be impoſſible to break the Lode away clean and free from waſte of the adjoining country without it is firſt Dizhued: accordingly they obſerve which of either wall or ſide of the Lode is the moſt fair, and eaſily to be broken, and purſuant to that or any other contingent circumſtance, they break down firſt of all ſome part of one wall and contiguous ſtratum by the Lode, as hath been before deſcribed, and afterwards the Lode being thus far Dizhued is taken down clean by itſelf. On the contrary, if one part of the Lode is very rich and fair, but ſmall, and the reſt of it is dry, barren, large, and hard, they commonly dig out firſt the pith or richer part of the Lode, which they call Hulking the Lode; ſo that in ſuch caſe, the poor part which is left ſtanding may not improperly be named a Dyzhu of the dead unprofitable part of the vein; which, if it is very hard, they uſually deſtroy or break down by a charge of gunpowder.

For the more eaſy comprehenſion of the reader, it is to be obſerved, that Hulking of Lodes, is the term moſt generally uſed in driving a high end, or ſinking a high ſtope of the Lode; and that Dyzhuing the Lode or the Leader, is moſt uſed where the barren part of the Lode, or the adjoining country, is very fair, or more ſo than the rich part of the vein. The interchange of terms, ariſes from the converſe of the foregoing contingencies; for Hulking the Lode, is only uſeful where the country, or barren part of the vein, is much harder than its richer parts.

In Dyzhuing or Hulking the Lode, a ſuper abundant quantity of deads muſt conſequently incommode the workmen, and fill up the Mine, if not ſpeedily drawn up to graſs or diſpoſed of in ſome vacant place. The drawing ſuch portions up to the ſurface,

ſurface, muſt be very tedious, and as coſtly as drawing up equal quantities of the richeſt Ores. Now in order cheaply and ſpeedily to diſpoſe of their refuſe or deads, if the Mine has been worked any tolerable depth, they lay over their heads, acroſs the fiſſure or evacuated workings, great beams of timber mortiſed into the ſolid rock; and acroſs upon thoſe beams, firm planks of deal, which make a ſtage or gallery, denominated a Stull, from the Britiſh word Aſtel a board or plank. Several of theſe Stulls are made in different depths of Mines, that are of any ſtanding; and we find they are many ways uſeful to the Mine and workmen; for by ſuch coverings over head, the workmen are oftentimes preſerved from great danger by the falling of Scals, or the tumbling down of rocks and ſtones from various places of the workings over them. Theſe Stulls are doubly uſeful to the Mine; for all the deads or refuſe part of the workings before mentioned, are conveniently thrown to Stulls, as they ſay, to the ſaving of much labour and great expence; and at the ſame time, when thus filled with Attal or deads, they help to prop or keep open the Mine from being cruſhed together by the incumbent ſtrata or country. One only inconvenience, that I know of, reſults from the making of Stulls in a Mine; that is, they often ſerve for concealing Ore under-ground, which the combined knavery of the workmen, with the connivance of the captains, may place there till it ſuits their opportunity to remove it for their own advantage to mix with Ore upon tribute, where they are largely concerned. All publick undertakings are more expoſed than private ones, to the peculations of diſhoneſt ſervants.

In ſome Mines, where Ore is broken more ſpeedily than it can be drawn up to graſs, (and I have known ſome Lodes ſo fair and rich that one pick-man would keep a whym conſtantly going) it is neceſſary for them to have a place under-ground, diſtinct from the Shafts and Stopes of the Lodes, for lodging their Ore, till they are at liberty to bring it to graſs; particularly where they are driving a drift either upon Ore or deads. This place, if it is dug out of the ſolid rock or country, they call a Plot, or cutting a Plot. The Plot (commonly called the Plat) is ſeldom under twelve feet ſquare and ſix feet high; but it may be much larger according as circumſtances require. At the entrance or beginning of almoſt every Drift, a Plot, or chamber, is convenient to lodge the broken ſtuff on, almoſt as ſoon as it is broke, that it may not incommode the working of the drift end; and it is alſo more neceſſary at the top of the Little-

Little-Winds or under-ground Shaft, that communicates with the ſide or bottom of the upper or graſs Shaft. It may appear ſtrange to ſome of my readers, how Shafts under-ground, like thoſe above, can be neceſſary or even practicable; but it is very true, that few Mines are without many of them; and that, in the workings of former times, they were more numerous than graſs Shafts.

The under-ground Shaft or Winds, is worked by hand, with a windlaſs only; and its area is not ſo large as the graſs or working Shaft; whence it is corruptly abbreviated the Little-Winds. Now that we may underſtand how neceſſary the Little-Winds is to the working of a Mine, the reader will be pleaſed to remember, what I have before hinted, that Lodes in their underlie, go away from the Shafts, in which the work or Ore is brought up: the Shafts are thereby rendered uſeleſs in courſe of time, and therefore it is commonly requiſite to ſink down new Shafts, and cut the Lode at a deeper underlie, that they may draw up the work perpendicularly with greater facility. But thoſe Shafts in deep Mines, are often coſtly, and troubleſome to be ſunk, from the ſurface of the earth; either by means of the water that falls into them, the intenſe hardneſs of the ſtratum they muſt cut through in ſinking, or by means of looſe ſoft ground, that requires much timber and boards to line the Shaft from top to bottom. When they find any of theſe difficulties very great, they ſink a Little-Winds in this manner: they go down in the graſs Shaft, from whence the Lode is gone ſo far as the Shaft is perpendicular, or as far as they think proper; from thence they work in a drift or horizontal line, till they come as far over the underlie of the Lode, as they like: there they cut a Plot; and in the middle of this Plot they fix a windlaſs or winding tackle, and ſink down their Little-Winds or Shaft until they cut the Lode in it, or to the depth they intended. If the Plot is not ſufficiently large after the Winds is ſunk, they make it wider, for holding the work they wind up from the deeper workings; whence the men roll it away in wheel-barrows to the graſs Shaft, where is another Plot, Saller, or ſtage of boards, to place it on, from whence they draw it up to the ſurface at their leiſure. Hence it appears, that both the graſs Shaft, and Little-Winds, are put down in ſtrait lines; and they would be parallel to each other, had the Winds been continued up to the graſs or ſurface; but the line, or drift of communication common to both, is horizontal and at right angles

angles to each other; and goes from the foot or ſide of the graſs Shaft, to the top of the Winds.

We may conclude, that the number and neceſſity of theſe under-ground Shafts in a Mine, greatly depends upon the horizontal tendency of the Lode: for if a vein goes down nearly perpendicular, the graſs or working Shaft will anſwer its purpoſe very well; but if it inclines faſt, or underlies a fathom in a fathom, that is, if for one fathom in perpendicular depth which the Lode is ſunk upon, it is gone likewiſe a fathom to the north or ſouth, the uſe of the Winds ſoon becomes neceſſary. And though there is a great expence in ſinking theſe under-ground Shafts, and cutting of Plots, yet their uſefulneſs counterballances it, where a great waſte of ropes and expence of draft are occaſioned by dragging upon the long and flat underlie of a deep Mine. In deep Mines, ſome whym ropes coſt fifty or ſixty pounds; and perhaps cannot be uſed with ſafety beyond two months if daily employed, on account of the great wear by dragging fifty or ſixty fathoms upon the inclination of the Lode; beſides the expence of putting four horſes to draw half the work, which two, but for the depth and impediment, might perform; it being well known, the Kibbal in ſuch caſes ſeldom comes up half full to graſs. Neverthleſs, theſe with many other difficulties are to be borne with in deep Mines incloſed by denſe ſtrata; and it muſt of conſequence follow, that the Winds is more eligible in a fair and feaſible country.

When a Mine is wrought very deep, it requires too much time to let many men down through the working Shaft, which is appropriated to the bringing the work or Ore to graſs; and therefore their underlying Shafts, which are become uſeleſs, and out of courſe of working, are converted into a foot way. To make a good foot way, they build a Saller or landing plot of boards, on which they reſt the foot of a long ladder, the other end whereof reaches up to the top of the Shaft at the ſurface; then, from the foot of the ladder, they have an horizontal paſſage to another deeper Shaft on the underlie of the Lode, where they have another Saller or landing place, and fix another ladder to deſcend deeper; and thus they proceed, till they have ladders enough to go down to the bottom of the Mine. Yet it is very common in great Mines to have foot ways by ladders in their engine Shafts, which not only ſerve the purpoſe of going down into the Mine, but alſo of inſpecting every crevice of the pumps that have loſt water, that they may rectify them when any misfortune happens. Thoſe ladders in the engine Shafts are of various lengths; but at the foot of each ladder there is placed a Saller for it to reſt upon, above which, the top of the next ladder preſents itſelf.

Either in driving an Adit, or ſinking a Shaft in looſe mouldering ſtratum or country, they are often obliged to bind and ſecure them with timber, to prevent the country from running into the workings, and thereby choaking them. If the ground is very looſe on all ſides, they make a Durns, as they call it, which for a Shaft is ſquare like the frame of a window, and for an Adit is the ſame as a door caſe. Between the Durns and the country they thruſt in deal boards, whoſe extremities length ways are juſt placed behind each Durns; by which means the looſe ground is kept ſecure from filling the workings and deſtroying the men. This, in an Adit, or any other drift, is called Binding or timbering of it; but in a Shaft, it is Collaring the Shaft; and indeed every Shaft, before it is ſunk into the hard rock, or while it is in the rubble of the country, muſt be thus Collared; and the top is thence uſually denominated The Collar of the Shaft.

All deep Mines likewiſe require to be well propped and ſupported with ſtemples or maſſy pieces of wood, which being boarded over make Stulls, as I have already obſerved. Theſe ſtemples or pillars of wood, which ſome call Lock-pieces, are generally placed perpendicularly, one end being fixed under the upper or hanging wall of the Lode, the other end reſting on its underlying wall; ſo that theſe pillars ſuſtain and keep up, not only the roof or hanging wall of the Lode, but alſo the prodigious weight of the impending ſtrata or country. I have ſeen thoſe maſſive pillars cruſhed almoſt together in ſome Mines, by their incumbent roof, and have been filled with horror at their appearance; and in other Mines, where the Lode has been wide and but little inclined, they have appeared like the pillars which form the aile of a venerable piece of Gothick architecture. But to ſave the charge of the timber, and coſt of breaking the fruitleſs part of the vein, they often leave pillars of the Lode unbroken and ſtanding, eſpecially if they are poor in nature, and of a hard ſtony conſiſtence; and by driving holes through thoſe pillars, which are called Arches of the Lode, they preſerve a communication with the reſt of the workings.

It

It requires much judgment to know when to ufe timber, and when to do without it; for an unfkilful perfon may at a great charge ufe timber where it is not wanted; or may apply it fo injudicioufly, that it may not anfwer the purpofe for which it was defigned. In this branch of Mining, indeed, many expert Miners are not verfed; and therefore it is generally undertaken by perfons who have made it their ftudy and employment; who are ufually called Binders and Timbermen; and who, according to their reputed excellence, have very great wages; for without a proper application of timber, both the workmen and Mine may be crufhed together and deftroyed. Of fuch an event we have had too many inftances; but if a Mine that has fuffered thus, is worth the charge of recovery, new Shafts may be funk down from grafs, till they come under the old bottoms, and by leaving over head a firm back or feparation, to fupport and keep up the run of the former workings, it will be again in as good a ftate as a new Mine.

If only fome part of a Mine falls in, or a ftull runs; that is, if it breaks down, and fills fome of the bottoms with deads; it is ufually cleared by fhutting of Attal; which is performed by introducing upright Durns, and driving deal boards pointed at one end, between thofe Durns, and the loofe Attal; and at the fame time clearing and fhoveling away the deads as faft as they can conjunctively proceed with Durns and Laths; by which latter name they call deal boards. By this procefs they carry a drift of communication through their Attal, to different parts of the Mine.

The great expence in hydraulick machinery that fome very deep Mines are chargeable with, very often induces the adventurers to ftop their workings for fome time, till they bring home a new and deeper Adit. Accordingly they look out for a place to take a level from, that will neither be expenfive, nor flow in the driving; and they put more or lefs force upon the Adit, as they are more or lefs earneft in the work. When they refolve to be expeditious about it, they are not fatisfied with driving one fingle end, but fink many intermediate Shafts between the loft flovan or tail of the Adit, and the Mine. In this matter, if they do not reflect maturely, and confider, whether they can fink fo many Shafts, without drawing much water, they may feverely pay for their improvident temerity. The greateft accuracy, fkill, and circumfpection are neceffary in dialing with a compafs for an exact and abfolute level between the

the Shafts and the Adit end. A ſmall error will be of great, very great ill conſequence; ſo that none but ſenſible, experienced Miners, ought to be truſted with ſo momentous a tranſaction.

The new Adit is ſeldom or never deeper, than the bottoms of the Mine; therefore the holding this deep level to the houſe of water, is very dangerous. All the former workings, if the Mine has been ſet idle, muſt of neceſſity be filled with water to the level of the firſt or old Adit. The whole Mine then becomes a houſe of water, according to the common expreſſion; and ſuppoſing they were abruptly to hole the Adit, or make a communication from it to the former workings, without any precaution; then the great weight and preſſure of the water, would force its way through ſo precipitately, that the ſtream would inſtantaneouſly fill the Adit, and the men could not eſcape drowning. Therefore, whenever they are apprehenſive of coming towards a Gunnies, or hollows of a Mine filled with water, they bore a hole with an iron rod towards the water, about a fathom or two, or ſo many feet, further than they have broke with the pick-axe according to the denſity, or different texture of the ſtratum in their Adit end. As they work on, they ſtill keep the hole with the borier before them that they may have timely notice of the burſting forth of the water, and ſo give it a gradual vent or paſſage, which will ſoon enlarge itſelf, and drain the Mine, when once it begins to pipe out of the borier hole into the Adit. Yet notwithſtanding all this care and prudence, they are often in imminent danger of their lives, and are ſometimes loſt by the ſudden eruption of the water. This very hazardous buſineſs is generally undertaken by enterprizing workmen for the conſideration of an advanced price; and I have met with ſeveral inſtances of its being attended with fatal conſequences.

In ſome places, eſpecially where a new Adit is brought home to an old Mine, which has not been wrought in the memory of man, they have unexpectedly holed to the houſe of water, before they thought themſelves near to it, and have inſtantly periſhed. Some have driven by the ſide of the houſe of water, and have periſhed alſo by its unexpected eruption. But I think where they are tolerably acquainted with their ſituation, much danger may be avoided, by keeping three or five borier holes before them, radiated or diſplayed above and below, to the right and to the left, from the center of the Adit. This advice however

however may not be relifhed by thofe who are impatient to be rich, and value a little money more than the lives of their fellow-creatures.

It often happens, however, where they are driving home an Adit upon the courfe of the Lode, that the water, as they come near the old workings, zighyrs away by flow degrees, through the Adit end, if it is tender and porous; and inftead of holeing to the houfe of water, they very happily hole to Learys, or the old Gunnies, or excavated parts of the Mine.

The new Adit being holed in to the old workings, they immediately prepare to draw out the water; and when the bottoms are forked, or quite unwatered, they proceed to clear them of all flime, fludge, and attal, that may have fallen into them fince the Mine was knocked or fet idle. Afterwards they fink, ftope, and drive in various parts of the Mine, according to the beft of their judgment, and in the manner before defcribed. The reader will conceive, that almoft every Mine, from variety of circumftances and natural contingencies, will require a different management, and method of working; and that one certain mode for working two different Mines is impracticable. We have only to remark, that no Mine can be well wrought without ufing the forementioned general methods, however varied they may be in the manner and application.

A General Difplay of a Mine, by Notes of Reference to and an Explanation of every Part of a whole Sheet Parallel-Section of Bullen-Garden Copper Mine; wherein is exhibited all the Machinery, and Workings, from Grafs to the Sumph, fhewing every Pump, Saller, Ladder, Drift, Stope, End, Winds, and Stull, in the Mine.

1,2 The weftern water engine tyes, or pumps, which deliver the water to adit.

3 The ciftern into which the water runs, from the old fire engine rofe pumps 17.

4 A fmall bore, or fmall pump.

5 A ciftern: the water which comes from Dolcôth Mine through the level 6, runs into this ciftern; it then afcends through the fmall bore 4 into the ciftern 3, whence it is drawn to adit by the pump 2.

6,6 An aqueduct or level from Dolcôth Mine.

7,7,7,7,7,7 Poles, or pump rods.

8 Old fire engine tye pumps.

9 The rofe ciftern.

10 A pump, that conveys the water from the rofe ciftern 9 to the tye pump.

11 Old fire engine rofe pumps.

} Clack door piece, and iron pump or cylinder 12½ inches diameter.

12 A ciftern.

13 Old fire engine crown lift.

} Clack door piece, and iron pump or cylinder 12½ inches diameter.

14 A ciftern.

15 Old fire engine lilly pumps.

16 New fire engine tye pumps.

} Clack door piece, and brafs pump or cylinder 11¼ inches bore or diameter.

17 A ciftern.

18 New fire engine rofe pumps.

} Clack door piece, and brafs cylinder or pump 11¼ inches bore or diameter.

19 A ciftern.

20 New fire engine crown pumps.

} Clack door piece.

21 Ciftern.

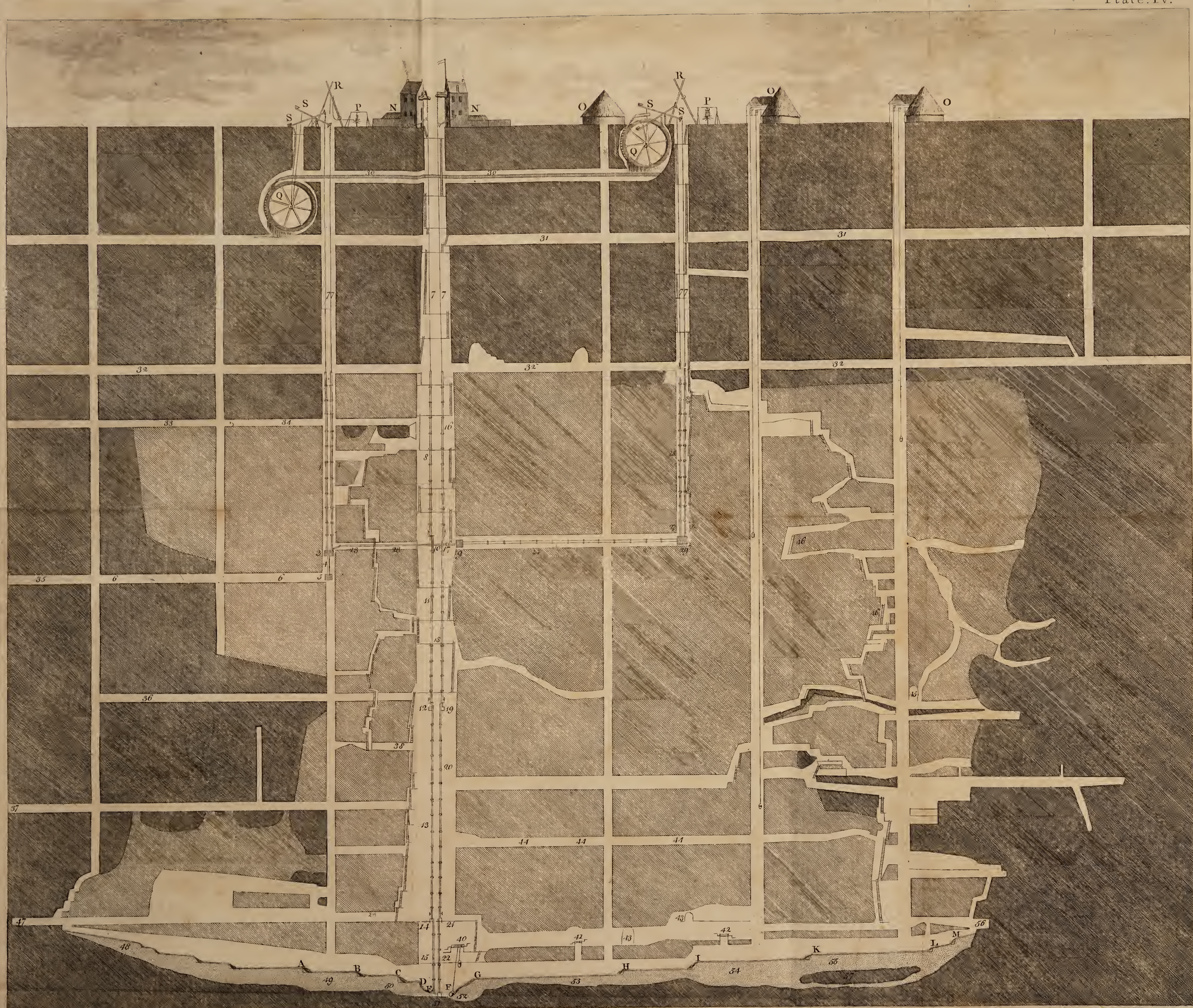
22 New

22 New fire engine lilly pumps.
23,23 Launders, to convey the water from the rofe ciftern 9, to the weftern water engine.
24,24 Wooden pumps, to convey the water from the rofe ciftern 9, to the eaftern water engine.
25 Eaftern water engine great tye pumps.
26 Ditto little tye pumps. Both thefe tyes or lifts draw to adit all the water from the ciftern 9, which comes to them through the wooden pumps 24,24.
27 A brafs cylinder or pump, 11 inches bore.
28 Ditto, 10½ inches.
29 A ciftern.
30,30 A fhallow level or aqueduct, that conveys the water, after it is difcharged from the eaftern water engine wheel, to the top of the weftern water engine wheel, to work that alfo.
31,31 The old level or adit.
32,32 The new level or deeper adit.
33,34 A level to Dolcôth fire engine fhaft.
35 Huel-Bryant drift, or a deeper level driving to Dolcôth.
36 A drift.
37 Kemps end.
38 The broad ftull.
39 The long faller.
40 A winds or windlafs, to draw deads, or attal, from the fumph to the ftull.
41,42 A winds to draw attal from the bottoms to the ftulls.
43,43 Drifts, driven to the north branch.
44,44,44 A ftull and way to the top eaftern end.
45 A drift to fouth Entral Mine.
46,46 Foot-ways and ladders.
47 The deep weftern end, or ftool.
48 Weftern bottoms.
49 Weftern fhaft bottoms.
50 Sumph fhaft weftern bottoms.
51 The fumph.
52 Sumph fhaft eaftern bottoms
53 South fhaft bottoms.
54 Tyacks bottoms.
55 Eaftern bottoms.

56 The

56 The deep eaſtern end, or ſtool.
57 A horſe in the Lode.
48,49,50,51,52,53,54,55 The breadth or bigneſs of the Lode, in the deep bottoms.
A,B,C,D,E,F,G,H,I,K,L,M Stopes on the Lode.
N,N Fire engines.
O,O,O Whyms.
P,P Capſtans.
Q,Q Water engine wheels.
R,R Triangles, rope, and ſheaf, for raiſing the pumps, changing boxes, &c.
S,S Water engine bobs.

CHAP.



Richard Phillips Del.   J. Barber & T. Kitchin Sculp.

A Scale of Fathoms

8 16 24 32 40 48

To Francis Basset Esq.r this PARALLEL SECTION of BULLEN GARDEN MINE in the Parish of Camborne Cornwall

Engraved at his Expence Is most gratefully inscribed By WILLIAM PRYCE

CHAP. IV.

General Obfervations on Mines, and the Management of them.

HAVING treated, in the preceding chapter, of the manner of working Mines, I fhall now make thofe obfervations, which are confequent to the working of fome Mines, and not of others; and likewife circumftantially explain the arrangement and conduct of the labourers in their feveral departments.

Mining is fo expenfive in its operations, and fo uncertain in its fuccefs, that few or none of our Cornifh Mines are carried on at the rifk of one or two perfons. Where there are fo many blanks to one prize, it would be gaming in the extreme, for any perfon fingly to begin a feeking adventure; or indeed, to take up any thing of the kind, which is not already difcovered, and likely to be rendered profitable almoft to a certainty: and, upon this ground, it generally happens, that the charges of our adventures are borne by many partners, from four to ten, fixteen, twenty-four, and thirty-two. The fhares in thefe adventures, are often fo fractional and intricate, that a ftranger, though a tolerable arithmetician, would be greatly at a lofs to divide and appropriate the Doles or fhares, with that precifion, which is familiar to many illiterate Tinners, who can caft a piece of ground, and affign the proportions of a parcel of Copper or Tin Ore, with the utmoft accuracy, by the help of twenty fhillings, pebbles, or buttons.

The principal manager in the Mine, is the Purfer, or Bookkeeper; who keeps all the accounts, and receives and pays all the money. This perfon is ufually one of the adventurers; and is chofen by the reft, for the adminiftration of their affairs, during the intervals of their monthly-meetings; at each of which, a ftate of the tranfactions and accounts of the Mine is produced, and after it is regularly examined and paffed, the total charge is divided according to the Doles or fhares, of which each adventurer is obliged to pay his refpective quota. The adventurers prefent at thefe monthly-meetings take into confideration the moft effectual methods of working the Mine; and their determinations, which are fettled not by voices but fhares, are conclufive for the whole body.

Deep chargeable Mines are carried on by perfons of fortune or great fkill; but fhallow Mines are occupied indifferently either by fuch, or by the labouring Miners, and frequently by both. When the Book-keepers, or any other officers, by fupplying coal, ropes, candles, or other materials, are part adventurers, they are always ftiled In-adventurers; and thofe who live at a diftance from the Mine, or have no immediate intereft by fupplying the works with Materials, are called Out-adventurers. By the Stannary laws, indeed, the latter have the fame privilege of fupplying a Tin work with men or materials in proportion to their refpective Doles; and when this is exercifed in oppofition to certain In-adventurers, it is productive of much jealoufy and conteft; fo that it is more advantageous to Mines, when they are difinterestedly carried on, and fupplied with Materials, by perfons who have no property in them. In this cafe, the bickerings of contending interefts are prevented; and the Out-adventurers are fatisfied, that too many materials are not crouded upon the Mine by favour and connivance: and yet it is but reafonable, that thofe adventurers who are in trade, fhould have the preference in fupplying a Mine with Materials, when it can be done with probity and honour.

In large and important Mines, befides the Book-keeper or Cafhier, there is a fuperintendant over all, called the Captain; who having the direction of the works both above and underground, ought to be an experienced practical Miner, and to underftand every diftinct branch of the bufinefs. Under him, are the Bottom-Captains, whofe bufinefs is to fee that the common men perform due labour down in the Mine, and that they do not promifcuoufly confound the good and bad Ore together, but break them feparately, or as nearly fo as poffible; and alfo, the Grafs-Captain, who directs the feparation of the Ore again above ground, fo that the beft or moft folid parts of it be made fit for fale, efpecially if it is a Copper Mine, for which reafon, fome call him the Dreffer: but whether as Captain or Dreffer, having little more to do, than to direct the repair of what goes amifs in the Bal or Mine, among the horfes, whyms, carriers, fmiths, carpenters, &c. if he can keep a tolerable journal or day book, he alfo delivers materials to the men, fuch as gunpowder, candles, fhovels, pick-hilts, &c. and is on that account often called the Material-Man.

Though it is much to be feared that adventurers are often injured by difhoneft captains, in conniving at the impofitions of the

the common men; yet I muſt declare my opinion, that many private peculations originate from the parſimony of the maſters themſelves. It is an aphoriſm in Mining, that "A Tinner has "nothing to loſe;" but upon tribute or ſearching for Tin upon the mere ſtrength of his labour, he puts himſelf in the way of fortune, to enrich him by one lucky hit. It is ſaid, "A Tin-"ner is never broke till his neck is broke;" for though he may loſe all his labour this month upon tribute, the next may amply repay all his loſs with profit. I, therefore, reckon a Tinner upon tribute, if he can clear thirty ſhillings monthly, with the chance annexed of gaining four times as much, is better off than a captain at forty ſhillings without any further chance. There will never be occaſions wanting for bad men to decoy ſervants, and alienate them from their bounden duty to their maſters: accordingly, Takers of ground by the fathom in ſinking, ſtoping, or driving, and likewiſe Takers upon tribute, invite the captains to drink with them, upon free coſt, at publick houſes; which leads to a further progreſs in deceit and corruption, till the incautious captains are ſeduced from their integrity by the preſents of the Takers, whom they ſuffer to mix and manage the Ores in ſuch manner as will moſt conduce to their own advantage; and to meaſure the ground which is wrought by the fathom, to the loſs and injury of the adventurers. Inſtead, therefore, of allowing the captains to draw the work with their own horſes, and to ſell the workmen materials and proviſions, the adventurers in every Mine of great conſequence, ought to give them handſome wages, with a ſtrict prohibition not to have any private intercourſe with the Takers.

But, inſtead of dwelling on the faults of this uſeful body of men, which are not greater than thoſe of others who are equally deſtitute of the advantages of Chriſtian inſtruction and good example, and which the wiſdom and generoſity of their maſters might in a great meaſure reſtrain; we ought rather to conſider the number and ſeverity of their diſtreſſes, and the moſt probable means of affording them effectual relief.

The principal part of theſe ariſes from the caſualties that continually befal them, and require the immediate application of chirurgical aid. It is common for the owners of a Mine to oblige the men to depoſit twopence ℔ month with the purſer, for the payment of the ſurgeon belonging to the Bal; and as all who work leſs than five ſtems, and generally all labourers at graſs, are exempted from this contribution, it is levied only upon

upon thofe who are in conftant and imminent danger: and for this fum of two fhillings ℔ annum from each contributor, the furgeon undertakes to attend at all times however unfeafonable, and at all places however diftant, and to perform all operations, and furnifh all medicines. This kind of contract has fubfifted near fixty years; but unfortunately for thofe unhappy labourers who may hereafter want affiftance, the furgeons begin to be weary of it, and are gradually declining a practice, which, ufeful and important as it is to the fufferers, affords no recompence in any degree adequate to their own fkill, labour, and expence. Suppofe, for inftance, that a Mine employs three hundred men who contribute to the payment of the furgeon; twopence monthly from each, amounts to thirty pounds ℔ annum. Now, in the courfe of a year, it is three hundred to one, that the trepan, or the crooked knife, will be wanted, not only once or twice, but very often; befides the ordinary accidents of burns, wounds, contufions, luxations, or fimple and compounded fractures, where the knife is fpared; and the blafting one or both eyes, and the two laft fingers of the left hand, by gunpowder. An accident of confequence may require at leaft fix weeks daily attendance five or fix miles diftant from the furgeon's refidence; an accident of the like nature may require the fame attendance, at the fame time, a road five or fix miles diametrically oppofite: and is there a recompence for all this attention and labour, that is likely to fecure the continuance of it?

We wifh not that any Mine fhould be attended by one particular furgeon: we know it is for the advantage of a patient in the progrefs of his cure, to be under the care of that furgeon to whom his own affection or opinion moft inclines him; and when the cure is completed, or the furgeon has done all in his power to effect it, let his bill be difcharged by the purfer of the Mine, purfuant to ftated prices. If this, or fome plan like this, is not adopted, the poor labourers muft perifh very faft for want of neceffary help; for to fuppofe a continuance of the prefent method, is paying no compliment either to the underftanding of our furgeons, or to the compaffion and prudence of the Mine adventurers.

But the moft effectual relief for all thefe evils, is a publick hofpital. In almoft all the large and opulent counties in England, hofpitals are erected nearly upon the fame plan as thofe in London: and it is ftrange, that a county fo large as Cornwall,

fo

fo opulent, and abounding with fo many accidents that require the greateft care and expertnefs in furgery, fhould be fo long without a charity of this kind : I am forry to obferve, it is no proof of the wifdom and generofity of its nobility and gentry.

If the annual proceeds of this county in Tin, Copper, and Fifh, are rated only at £400,000, it is generally known, that feven-eighths of that fum are produced from the Mines, by a bufinefs the moft hazardous under the fun to health and life. As a maritime county, it has a great commercial intercourfe with the whole world, by exportation of Tin, Fifh, and Oil, and the return of Salt, Hemp, Iron, Timber, &c. : and the conveyance of our Copper Ores coaftways, and the return of Coal and Lime, together with our fifheries, and the number of foreign packet boats at Falmouth ; keep up no inconfiderable fleet of fhipping, and form a valuable nurfery of feamen. Surely then, the Mining part of this province muft be the moft proper and eligible fituation for an hofpital, for fick and wounded Miners and Sailors. And as Redruth is fituated on the narroweft part of the county, is the center of Mining, and within two hours diftance from our moft frequented fea ports ; all thefe circumftances combine to prove the expediency of erecting a county hofpital clofe by the town of Redruth.

When an accident happens in a Mine, the poor fufferer languifhes till the arrival of the furgeon, who is generally fent for in fuch hafte and confufion, that it may happen, he is not provided with every thing proper to adminifter prefent relief. I have been called to a perfon fuppofed to have a compound fracture of the leg, by a fall twenty fathoms under-ground, and have brought a fuitable apparatus ; when the cafe has proved to be a fractured fkull, and the leg was only fcratched. The patient is then conveyed fix or feven miles to his own hut, full of naked children, but deftitute of all conveniencies, and almoft of all neceffaries. The whole, indeed, is a fcene of fuch complicated wretchednefs and diftrefs, as words have no power to defcribe.

How comfortable then, muft it be, to fuch miferable objects of compaffion, to be carried to an hofpital furnifhed with every neceffary to effect his cure, and every convenience to alleviate his diftrefs ! The fame trouble which removes him from the Mine to his wretched hovel, brings him to the place built and furnifhed for his peculiar benefit.

The more I confider this matter, the more I am convinced, the accomplifhment of it may be well and certainly effected. A voluntary fubfcription among the nobility and gentry; the lords, bounders, and Mine adventurers; the Tin and Copper companies; the merchants and owners of fifheries; and every rank and degree of thofe, who are any ways concerned and connected with the county; would raife a fufficient fum, to build and furnifh a large commodious hofpital; which, afterwards, may be almoft wholly maintained and fupported by the monthly contributions of the Miners, failors, and fifhermen. Suppofe the whole body of Miners, including all who work at grafs as well as under-ground, men, women, and children, in dreffing of Tin and Copper Ores, either in the Bals, or at the ftamping mills, were taxed at only threepence a month each: fuppofe they amounted only to 20,000, and the failors and fifhermen to half that number; the whole would raife an annual income of £4,500, free of all drawbacks, and exclufive of the revenue from legacies, and annual donations and fubfcriptions. Hoping an object fo interefting to the wife and wealthy part of the county will meet with fpeedy attention and effectual encouragement, I return to our principal fubject.

When a Mine is incumbered with much water, it occafions a confiderable increafe of labour and coft; it then becomes neceffary to ufe all poffible difpatch and diligence in working the Mine, and raifing the Ore without any interval. When the pick-axe ought to be kept conftantly at work, it is ufual to work ftopes or drift ends by double pick-men; allowing two men to each pick by day, and as many by night, if they work twelve hours core. Thofe long cores, however, are now generally abolifhed: when they were cuftomary, they were nothing more than a pretence for idlenefs; twelve hours being too many for a man to work under-ground without intermiffion. Accordingly, when a pair of men went under-ground formerly, they made it a rule, to fleep out a candle, before they fet about their work; that is, if their place of working was dry, they would lay themfelves down and fleep, as long as a whole candle would continue burning; then rife up and work for two or three hours pretty brifkly; after that, have a touch-pipe, that is, reft themfelves half an hour to fmoke a pipe of tobacco; and fo play and fleep away half their working time: but Mining being now more deep and expenfive than it formerly was, thofe idle cuftoms are fuperfeded by more labour and induftry. Conformable to the humidity or drinefs of the place, the

the denſity or fairneſs of the ground, and the diſtance from the ſumph, it may be more or leſs neceſſary, to work in cores of ſix or eight hours with double picks. To work with double pick-men, they allow two men to one pick in this manner: in ſtoping or driving fair ground, one man works two hours, and then gives the pick to his companion to work with for the ſame time, and he that ſtands by rolls or carries off the broken Ore or ſtuff as there is occaſion; and thus they work and carry off alternately. So likewiſe in boring of rocks for blaſting with gunpowder, one man holds the ſteel borier, whilſt the other beats it with a ſledge of ſix pounds weight: the latter having had the hardeſt taſk, when the hole is bored to its intended depth, reſigns the remainder to the perſon who had only held the borier, who charges the hole, fires it, and works away the ſhattered rocks.

After this manner they work out their core till freſh men come under-ground, and relieve them in place: but ſometimes they are neceſſitated to work conſiderably longer than their ſtated hours; and then they are ſaid to make a ſtem, or part of a ſtem, or to work a ſtem out of core; for which they are entitled at the month's end to an additional pay for ſo many ſtems as each man makes, over and above his ſtated time of working: but as this is an inlet to many impoſitions, it ought not to be allowed except upon a great emergency.

A Lode that is large, fair, and rich, will ſometimes produce Ore in ſuch quantities, that the men cannot wind it up, and diſpoſe of it, as faſt as it is broken; and the want of more plots and room to hold it, greatly retards their operations. In this caſe, the owners ſet the winding up of the work ſo broken, on the Whip; that is to ſay, over and above the men's ſtated wages, they give them a ſmall gratuity for every hundred kibbals of Ore that are brought up to graſs out of core: but, in this winding by the whip, a ſtrict attention ſhould be paid to the filling the kibbals to the brim, and alſo to making a lawful tale of five ſcore to the hundred, for reaſons too plain to be mentioned. This method, however, is only purſued in ſhallow Mines, or at leaſt where Whyms are not erected. Whyms or engines drawn by horſes, have larger kibbals; and can diſcharge more work, not only for that reaſon, but becauſe they may be kept conſtantly employed where the quantity of Ore or ſtuff is very great.

It

It is a good and a cuſtomary way for the owners to ſet their dead ground, either in or out of the Lode, to be ſunk, driven, ſtoped, or cut down, by the fathom: but if there is no choice in reſpect of ſaving the Ore clean, or the like, they ſet it to be ſunk, driven, ſtoped, or cut down upon Tut; and in ſuch caſe the Miners take what they term a Tut-bargain; that is, a piece or part of unmeaſured ground, by the lump, for ſuch price as can be agreed upon, expreſſing the ſituation and ſuppoſed dimenſions of the ground. This is not only beneficial to the owners, but alſo to the workmen: every one knows, that a labourer employed for daily hire, will not execute that quantum of labour for his maſter, that he will upon his own riſk and account; and, therefore, it is profitable for the Mine owners, to ſet all their work upon Tut, that can with propriety be ſo ſet; and it is likewiſe an incitement to the induſtrious Tinner, to acquire additional gain conſiſtent with a good conſcience, and his duty to his employers.

Under certain reſtrictions, it is alſo many times proper, to ſet an end to drive, or a ſhaft to ſink, at ſuch a price ℔ fathom, for as many as can be driven or ſunk for one month; or to drive ſo many fathoms certain. For inſtance: I have plain feaſible ground in my working ſhaft, that I am ſinking to cut the Lode upon its underlie. I ſet it to ſink by two men in a core of every eight hours; and ſuppoſing the men to deſerve £3 ℔ fathom, I conclude they may ſink four fathoms in one month, which will amount to £12 between ſix men, for which they find every thing but running tackle. Candles and ſmith's work deducted, it may be, thoſe workmen may clear for their labour thirty ſhillings each, which every good labouring Tinner well deſerves: but ſuppoſing that an alteration of ground may be expected in my favour, I ſhall then be unwilling to ſet by the month, and will allow them to ſink two fathoms only at that price; whereby I have it in my choice to ſet for a leſs price, if the ground becomes more fair after the ſtipulated fathoms are ſunk. In much harder ground, that deſerves ſix pounds ℔ fathom, though the ſame men may ſink three fathoms, amounting to £18, yet their gain will be no greater than in the former caſe, on account of their additional coſt in ſmith's work, gunpowder, &c. The ſame will hold equally true in driving or ſtoping: but matters of this kind are ſo complicate and various, that it would be an endleſs taſk to explain them all.

When

When they ſet a Lode to be broken by the fathom, they are particular in expreſſing its ſituation and other circumſtances, as all ſuch tranſactions are or ought to be determined by a publick ſurvey. Sometimes they ſet it by the cubick fathom; for though they muſt often break it irregularly, becauſe the Lode may be ſmaller in ſome places than in others, and by means of pillars or arches which they often leave ſtanding; yet when the contract is finiſhed, they meaſure the breadth, length, and depth of each particular place, and adding theſe together, and dividing the amount by two hundred and ſixteen, the quotient is ſuppoſed to ſhew the number of cubick or ſolid fathoms, broken by the labourers.

But it is much more uſual to ſet the breaking of the Lode by the ſquare, or ſuperficial fathom; ſtill remembering the depth that muſt be broken, as they work along. When the bargain is performed, the captain meaſures the length and breadth of each particular place; and adding the particulars into one ſum, and dividing that by 36, the quotient gives the contents in ſquare fathoms. If the men are deficient in the depth they were obliged to carry with them, they ought to make it good, before the agreement can be ſaid to be performed. In breaking of ſolid ground, however, they are generally compelled to carry or work the Lode, &c. by a certain breadth or width, called the Gunnies; that is a Gunnies of either three, four and a half, or ſix feet wide; which are denominated by ſome, a ſingle Gunnies, a Gunnies and a half, or a double Gunnies wide. A Gunnies is expreſſive of any certain meaſure in breadth. Now with reſpect to the meaſure of ground ſo broken, it is more maſterly and conciſe, to take the dimenſions in feet and inches, which may be reduced into fathoms by the following plain examples.

Suppofe a piece of ground meafures as follows : viz.

	Feet.	In.		Fath.	Feet	In.
Length	27	4	=	4	3	4
Depth	8	9	=	1	2	9
				Gun.	Feet	In.
Breadth	4	6	=	1	1	6

Q. How many are the Fathoms, at three feet to the Gunnies ?

Method of Solution.

	Fath.	Feet	In.			Fath.	Feet	In.	
	4	3	4		by	1	2	9	
$\frac{1}{3}$	1	3	1	4					
$\frac{1}{4}$		2	3	4					
$\frac{1}{2}$		1	1	8					
						Gun.	Feet	In.	
	6	3	10	4	by	1	1	6,	which is a Gunnies and half.
$\frac{1}{2}$	3	1	11	2					
						Fath.	Feet	In.	
	9	5	9	6	Content	9	5	$9\frac{1}{2}$,	at £3 ℔ Fathom.

Amount £29 18 4.

Suppofe a piece of ground meafures as follows : viz.

	Feet	In.		Fath.	Feet	In.
Length	19	9	=	3	1	9
Depth	4	4	=	0	4	4
				Gun.	Feet	In.
Breadth	5	6	=	1	1	6

Q. How many are the Fathoms, at four feet to the Gunnies ?

Method of Solution.

	Fath.	Feet	In.				Fath.	Feet	In.
	3	1	9			by	0	4	4
$\frac{1}{2}$	1	3	10	6					
$\frac{1}{3}$		3	3	6					
$\frac{1}{3}$		1	1	2					
							Gun.	Feet	In.
	2	2	3	2		by	1	1	6
$\frac{1}{4}$		3	6	9	6				
$\frac{1}{4}$		1	9	4	9				
							Fath.	Feet	In.
	3	1	7	4	3	Content	3	1	$7\frac{1}{3}$

Suppofe

Suppofe a piece of ground meafures as follows : viz.

	Feet	In.		Fath.	Feet	In.
Length	13	10	=	2	1	10
Depth	9	8	=	1	3	8
Breadth	8	2	=	1	2	2

Q. How many are the Fathoms, at fix feet to the Gunnies ?

Method of Solution.

	Fath.	Feet	In.						
	2	1	10		by	1	3	8	
½	1	0	11						
⅙		1	1	10					
⅓			4	7					
					Gun.	Feet	In.		
	3	4	3	5	by 1	2	2		
⅓	1	1	5	1	8				
½			7	5	1	8			
							Fath.	Feet	In.
	5	0	3	11	9	8	Content 5	0	4

Further, If a plot be nineteen feet ten inches long, eleven feet feven inches broad, and ten feet three inches high, how many folid fathoms are therein, and what is the amount of the charge, at two pounds eighteen fhillings and fixpence ℘ fathom ?

	Feet	In.		Fath.	Feet	In.
Length	19	10	=	3	1	10
Breadth	11	7	=	1	5	7
Heighth	10	5	=	1	4	5

Method of Solution.

	Fath.	Feet	In.							
						Fath.	Feet	In.		
	3	1	10		by	1	5	7		
½	1	3	11							
⅓	1	0	7	4						
¼		1	7	10						
⅙			3	3	8					
						Fath.	Feet	In.		
	6	2	3	5	8	by 1	4	10		
½	3	1	1	8	10					
⅓	1	0	4	6	11	4				
⅓		2	1	6	3	9	4			
¼			6	4	6	11	4			
	11	0	5	8	4	0	8	at £2	18	6 ℘ Fathom.
								Amount £32	1	7¼.

But

But where there is no refpect to breadth, it is ufual to call it a fuperficial or common ground, in ftoping particularly. Suppofe, for inftance, a ftope of ground meafures fixteen feet nine inches long, and feven feet three inches deep; how many fuperficial fathoms are therein, and what is the amount at three pounds twelve fhillings ℔ fathom?

	Feet	In.		Fath.	Feet	In.
Length	16	9	=	2	4	9
Depth	7	3	=	1	1	3

Q. How many are the Fathoms?

Method of Solution,

	Fath.	Feet	In.				Fath.	Feet	In.
	2	4	9			by	1	1	3
$\frac{1}{6}$		2	9	6					
$\frac{1}{4}$			8	4	6				
	3	2	3			at	£3	12	℔ Fathom.

Amount £12 3 0.

We may with certainty pronounce, there can be no ftated rule given for the value of fetting ground to break by the fathom; for fome may be wrought for four fhillings ℔ fathom, and other ground may require twenty or thirty pounds.

It may be ftoped for 10s. or £4,
It may be driven for 5s. or £10,
And funk for 5s. or £25, and even more ℔ fathom.

It may probably anfwer better in other countries, to fet the ground to break on the monthly account or wages, provided the Captain who takes care of it, is a man of integrity and worthy of truft; for the great inconvenience that attends this Tut-work or bargains by the lump, or by the fathom, is, that if the ground proves hard and chargeable in the working, the labourer has no ability to go through with it, and confequently muft run from it, and leave it on the adventurers hands. There is then no fatisfaction to be had of the Takers of the bargain, becaufe they have not wherewith to make reftitution; and, therefore, to obviate this lofs, fome adventurers infert a provifo in the agreement, that a quarter or fome other part of the money fhall be referved, till the bargain is completed, in order to recompenfe the damage that may enfue on non-performance. Though I have

have ſeen this forfeiture impoſed in ſeveral Mines of great importance, I muſt take the liberty to diſapprove of it, for reaſons that will plainly ſhew its inſufficiency. A ſhaft may be ſet to ſink ten fathoms at twenty ſhillings ℘ fathom ; and the Takers may be obliged to forfeit one quarter of their earnings, if they run from or deſert their bargain. Perhaps the firſt ſix fathoms may be ſunk for five ſhillings each ; that is, the Takers have ſo far earned ſix pounds ; but the remainder of the bargain, being four fathoms, may require twelve pounds to finiſh it, by an alteration to harder ground. Now, in this caſe, if they deſert their bargain, and incur the forfeiture, they are only entitled to four pounds ten ſhillings ; and this they will readily accept of, as they may have earned that money in a few ſtems ; while the adventurers are obliged to reſet the ſhaft to another Pair of men, at the advanced price of three pounds ℘ fathom. Hence it may appear to be the intereſt of the adventurers to ſet the ground by the lump, or the fathom, when the ground in a ſhaft or any other part of a Mine is fair and tender, and not when it is hard and chargeable to be wrought ; as in one caſe, the Miners will undertake it at an eaſy rate, but in the other they will make a large demand, upon a ſuppoſition, or at leaſt a pretence, that the ground may ſtill continue hard. But inſtead of this it would be more eaſy for the men, and more ſecure for the owners, to ſet as many fathoms at a ſtated price as can be ſunk in a month : the men cannot gain great wages, nor ſuffer great loſs : and as ground that is very ſtiff or denſe, requiring ten pounds to ſink a fathom, may alter, and be ſet for a leſs value, it would be prudent in the adventurers to ſet but one or two fathoms at that price. Theſe matters, however, from the great interchange of circumſtances in different Mines, are too intricate to be diſcuſſed in this place ; and I wiſh I may not have incurred the cenſure of ſome Captains, for having ſo far interfered in the cunning workmanſhip of their order.

The quantity of ground that is broken annually in Corniſh Mining, if it could be calculated, would appear incredible. But though it is not in my power to aſcertain this matter, yet, for the entertainment of my curious readers, I will attempt to calculate the quantity of metallick Lode broken annually in Cornwall, by the returns of white Tin and fine Copper.

We will ſuppoſe the average produce of the county to be three hundred weight of Tin in one hundred ſacks of Tin-ſtuff.

Allowing one ſack to weigh one hundred and a quarter, then one hundred ſacks will be ſix tons five hundred weight; conſequently there muſt be one ton of Tin produced out of forty-one tons thirteen hundred weight. The county has been found to produce, annually, for ſome few years paſt, about three thouſand tons of pure Tin-metal; which multiplied by forty-two tons of Tin-ſtuff as above, gives the total ſum of one hundred and twenty-ſix thouſand tons of Tin-ſtuff ℔ annum.

The Copper Ore ſold upon an average for the laſt ten years, is about twenty-four thouſand tons ℔ annum, which produce nearly three thouſand tons of fine Copper. Now let it be ſuppoſed, that two tons of merchantable Ore are produced from every one hundred ſacks of one hundred and a quarter each as above: then twenty-four thouſand multiplied by ſix and a quarter, is equal to one hundred and fifty thouſand tons of rough Lode. To ſum up all, for about ſix thouſand tons of pure Metals, we muſt dig and dreſs (the far greateſt part by ſtamping mills) two hundred and ſeventy-ſix thouſand tons of Lode.

If this quantum of Lode which is worth the charges of dreſſing, is annually digged and raiſed from our Tin and Copper Mines, how much greater muſt that quantity be, which is not alive, but is a dead waſte or uſeleſs refuſe? I will venture to affirm, it may be a portion far greater than the foregoing: but ſuppoſe it to be equal, the ſum will then be five hundred and fifty-two thouſand tons of Lode. Now we all know, the tons of Strata, or country, which are broken every year, muſt be immenſe, when we conſider the number of Shafts, Winds, Adits, Drifts, Plots, &c. that are continually ſinking, driving, and cutting around us. I cannot form a method of calculating this; but if, with the former ſum, we make this equal to two millions of tons of Lode and Strata broken annually in our Corniſh Mining, I believe my countrymen will not think that I have exceeded the bounds of truth. All this will ſerve to ſhew the vaſt employment for men and cattle in our Mine country; which I am very confident might be much increaſed, and of courſe be of more national utility, provided we had a market and a price for our reſpective Metals; but as the caſe now ſtands, we labour under every difficulty and diſadvantage that can militate againſt us, which, as it is now moſt ſeverely felt by the commonalty of Cornwall, muſt be hereafter felt by the community in general.

When

When a Mine is in due courſe of working and produces Ore, the adventurers ſometimes find it better to ſet the Mine on Tribute, than to work it on their own account. The manner of ſetting or leaſing a Mine on Tribute, is this; ſome able Miner takes the Mine of the adventurers for a determined time, that is, for half a year, a whole year, nay even for ſeven years, as was the caſe at Bullen-Garden, and the means of her diſcovery. If it is a Tin Mine, he articles firſt to pay the Lord, or the Lord and Bounders if any, their ſhares or Doles, free of all coſt, in the ſtone made ready for the ſtamping mill. This muſt be ſuch a proportion of all Tin-ſtuff as ſhall be raiſed during the limited time. Of the remainder, he pays the adventurers one moiety, or one quarter part, according to the agreement, it being more or leſs in proportion to the richneſs of a Mine. For example: In a Tin Mine not bounded, the Lord grants for, perhaps, one-ſeventh: now the Tin-ſtuff, when it is properly ſized to ſtones not larger than a man's fiſt, is divided into ſeven Doles or piles; the Lord's Agent, Steward, or Toller, caſts lots upon theſe Doles by written tickets, ſix marked A, and one L, and which ever of them falls to his lot L, on that Dole he puts the turf, and upon the turf a ſtone. Three and a half of the ſix A Doles remaining may belong to the Tributor, and the other two and a half to the adventurers, which alſo is tranſacted by dividing and caſting lots as before. Where a Tin Mine is in waſtrel and bounded, the manner of dividing and caſting lots, is more complex.

In moſt Tin bounds, the Lord's part is one-fifteenth of the whole, and the Bounders part is one-twelfth, commonly only one-tenth of the remainder. For inſtance: The Tin-ſtuff is divided into fifteen Doles, one of which is marked by the Lord's Agent, as above, after the lots are caſt; then fourteen Doles remain, two of which are equally ſubdivided and carried to the other twelve. One of theſe, by lot as before, belongs to the Bounders; and that very likely muſt be ſubdivided again and again, it being for the moſt part the property of ſeveral perſons.

Of the eleven Doles to be divided among the adventurers and the Tributor according to the articles of their agreement, the adventurers ſhall have three Doles and one quarter of a Dole, and the Tibutor ſeven Doles and three quarters: they then caſt eleven lots, viz. three marked A, ſeven marked T, and one blank, and where this blank falls, that Dole is redivided into four parts, and lots are recaſt upon it; one A the adventurers part,

part, and three T the Tributors. This, however, is not all; the adventurers three doles and a quarter are again divided into eighths, ſixteenths, thirty-ſeconds, and ſixty-fourths, and even much ſmaller fractions, that each may know and carry away his own.

The Tributor again has ſeveral perſons concerned with him, who redivide their ſeven Doles and three quarters in like manner: and thus are theſe fractional complicated diviſions, which at firſt ſight would puzzle the moſt expert arithmetician, effected by our illiterate Tinners upon the ſimpleſt plan, and with the utmoſt dexterity, diſpatch, and accuracy. To any other but a Corniſh reader, it may appear ſtrange, that ſo much trouble ſhould be taken in dividing and redividing the Tin-ſtuff in this manner, when it might be carried and returned altogether, and the proportions reckoned in money; but this cannot always be done; for ſtamping mills are numerous, and the ſeparate eſtates of ſeveral people, whoſe value riſes in proportion to the uſe and employment they have for them; therefore if the Tin-ſtuff is rich, every one is ready to carry off his reſpective Dole or ſhare, immediately after it is divided out, and the lots are caſt.

The ſetting of a Copper Mine upon tribute, has this difference: the Tributor is at the ſole expence of digging, raiſing, and dreſſing, all the Ore that can be made merchantable; and the proceeds of ſales are received by the adventurers, who pay the Lord his one-ſeventh, one-eighth, or one-tenth part, which ever it is, in money. If it is one-eighth, that is two ſhillings and ſixpence out of every pound or twenty ſhillings, of the remaining ſeventeen ſhillings and ſixpence the adventurers may have eight ſhillings, and account to the Tributor for the reſidue, which is nine ſhillings and ſixpence: and thus, it is ſaid, "Petherick Kernick of Hantergantick, Abednego Baraguanath "of Towednack, Dungey Crowgie of Carnalizzy, and Degory "Tripeoney of Gumford, have jointly taken a Copper Mine "upon tribute for nine and ſixpence out of the pound."

When the adventurers thus ſet a Mine to farm, they oblige the Taker or Tributor to keep the Mine in good repair, and well ſecured with whatever timber is needful; the putting of which into the Mine, ought to be according to the ſkill and diſcretion of a perſon deputed for that purpoſe by the adventurers. They alſo ſtipulate with the Taker of the Mine upon tribute,

tribute, to work it regularly with a certain number of men; but not in dippas, holes, and corners, to encumber the adventurers, at their re-entrance into the Mine, with the charge of breaking and clearing the barren part or deads, which the Tributor would otherwiſe leave under-ground. It is very reaſonable that the Tributor ſhould be obliged to deliver up the Mine in good order and condition, at the expiration of the time ſpecified; and that the adventurers ſhould reſerve to themſelves and agents, a power of going down into the Mine at will, to examine if the premiſes be duly complied with and fulfilled.

So far we have been ſpeaking of a whole Mine, taken upon tribute; but it is much more common, and has been always the caſe in large Mines, to ſet ſeveral parts of them in ſmall portions of ground called Pitches. A Tribute-Pitch, conſiſts of a few fathoms in length on the courſe of the Lode: two Pitches may meet half way between two Shafts, and draw their Ore to that Shaft, with which either of them are connected. If a Pitch is high up in the Mine at a ſhallow level, it is called a Pitch upon the Backs; but if lower down, in or joining with the bottoms, it is called a Bottom-Pitch. The time they contract for is generally four months, and to work the Pitch at all working times, in a regular manner with a certain number of men. The Tributor is obliged to work one month, or forfeit to the owners twenty ſhillings for every man he is obliged to employ; in lieu thereof, if he does not chuſe to continue at the month's end, he declines the occupation of his Pitch, and forfeits to the adventurers all the Ore which ſhall be broken.

The boxes and clacks or valves of the engine pump often go amiſs, and if they are not made of good leather well ſewed, a misfortune of that nature will happen almoſt every day; ſo that every method muſt be contrived, to have aſſiſtance at hand to man the capſtan, while a clack or a box is changing. Accordingly, a Tribute-Taker, as well as every other Miner in a Bal, obliges himſelf and partners to lend a hand gratis at the capſtan whenever required, upon the penalty of two ſhillings and ſixpence for each perſon reſpectively who refuſes his aſſiſtance. Without a regulation of this kind, a Mine would be in danger of ſetting idle, for want of neceſſary help: but when they cleanſe a boiler, which is once a month; or drop pumps, that is, let them down into the Mine; the adventurers charge each man at the capſtan a ſtem or a day's hire, and give them ſome

additional

additional recompence if the weather is fevere, or they make a long day's work.

The Takers of Tribute-Pitches in a Copper Mine, are likewife obliged to mix their Ores with thofe of other Pitches, or with the owners Ores; and to fample the fame according to the will and difcretion of the Captains; elfe the parcels of Ore would be very fmall, where they may be twenty Pitches upon tribute in one Mine. Before the parcels are mixed together, they take from each a fair honeft fample, and mark them A, B, and fo on, which they call private famples. The affay-mafter, who buys at the publick ticketing or fale a mixed parcel of Ore, hath thefe private famples given to him, which he affays for two fhillings and fixpence each with all the judgment and dexterity he is capable of, to make the moft of each; and it is a very rare thing for any complaint or diffatisfaction to arife from the appropriate difpenfations of our affayifts, fo expert are they in their bufinefs.

The ufe of private famples is this: though the fundry parcels of Ore which are mixed together for fale, may appear nearly of one value at fight, yet it muft neceffarily follow, that fome difference will arife from different management in the dreffing and other accidental caufes. In a mixed parcel of fifty tons, A may have twenty of fifteen pounds value ℘ ton; B may have twenty-five of fourteen pounds ten fhillings; and C may have five of fixteen pounds ℘ ton, according to the private famples; yet the grofs fifty tons may fell for fifteen pounds five fhillings ℘ ton. Neverthelefs the amount muft be divided among the Tributors according to the felling price, fubject to a regulation by the private famples; that is, the excefs or diminution, for what it fells, muft be proportioned by the produce of the private famples; for, if fifty tons fell at fifteen pounds five fhillings, the amount is equal to feven hundred and fixty-two pounds ten fhillings. Purfuant to the above private famples

		£.		£.
A's 20 tons at		15 —	=	300 —
B's 25	——	14 10	=	362 10
C's 5	——	16 —	=	80 —
The amount				742 10
which is				20 fhort by the private famples.

This is called £20 increafe by 762 10 which it fold for.

Now

Now the method of proportioning this twenty pounds increafe, is done by the rule of three direct, thus:

	£.		£.	£.			£.			
If	742	10	20	300	—	A	8	1	7½	increafe
If	742	10	20	362	10	B	9	15	4	increafe
If	742	10	20	80	—	C	2	3	0½	increafe
				742	10	add	20	0	0	
						Amount	£762	10.		

Here it is evident, that if the Adventurers were to account to the Tributors at the private prices, they would deprive them of twenty pounds of which they ought to have their refpective proportions, it being the abfolute value for which the commodity was fold. Alfo, by mixing thefe three parcels, they have altogether brought a better price by twenty pounds, than if they had been fold feparately.

The interchange of terms in this matter is very applicable, and eafy to be reconciled; for in cafe of a decreafe, that is, if the felling price had been feven hundred and fixty-two pounds ten fhillings, and the private famples had exceeded that by twenty pounds, making the whole feven hundred and eighty-two pounds ten fhillings, then the method of folution would be the fame by the rule of three, deducting each ones particular fhare, according to the amount of his Ore.

We may further illuftrate this matter, by entry of an account of Ores, fold and proportioned to the Lord, Adventurers, and Tributors.

Dolcôth Copper Ores weighed the 24th of March 1777.

Quantity			Price ℘ Ton		To whom fold	Amount		Lord's pt. 1-feventh			Adventur. net part		
Tons	⊕	Q.	£.			£.		£.			£.		
21	10	2	10	—	Cornifh Copper Comp.	215	—	30	14	3	184	5	9

Tributor's Account of the above Ores.

	Quantity			Price		Amount		Increafe			Amount			Tributors Part		Tributors Money		
	Tons	⊕	Q.	£.		£.		£.			£.			S.	S.	£.		
A	10	10	2	11	—	115	10	3	6	4	118	16	4	5 from	20	29	14	1
B	11	—	—	8	10	93	10	2	13	8	96	3	8	10 —	20	48	1	10
	21	10	2	Sold at £10 ℘ Ton £215														

By

By this time, I preſume, the reader has a pretty clear conception of the affair, and that each ſhare of the £215 ſtands thus:

The Lord's one-ſeventh -	£30	14	3	£215
The Tributors - - - -	77	15	11	
And the Adventurers net part	106	9	10	

The ſpirit of adventure hath many times ſo prevailed among the lower people, that very large ſums have been won and loſt by this kind of gaming, much to the injury of the caſhiers, who can have no recompence from poverty and rags. It is a method that will always anſwer for the adventurers, provided the Takers upon tribute will execute their part and fulfil their articles of agreement, which it is difficult for the adventurers to compel them to perform. Theſe reaſons have induced the adventurers in ſome Mines, to ſet their Tin and Copper Ore to break by the fathom; and I believe it is productive of more certain wages to the men, and larger quantity of Ore to the owners; which is of conſiderable importance to a Mine, obliged to ſupport a monthly charge of eighteen hundred or two thouſand pounds. It would be well if the Takers of Pitches on tribute, would allow ſo much in their calculations for the decay of a Lode; for it is generally known thoſe people commonly take a rich bunch of Tin or Copper Ore upon tribute according to its full value in ſight, not conſidering, perhaps, that it is almoſt impoſſible for ſuch to be richer; and that it is great odds whether it may continue half ſo rich for the limited time. This want of precaution plunges them into many difficulties, when an alteration of the Lode happens from riches to poverty: and, indeed, any perſon may conclude, that little more than common wages can be gained, by working a Pitch for twelvepence in the pound. Nevertheleſs, I have known ſeveral wrought at that value; and many ſcore tons of Copper Ore raiſed out of North-Downs Mine at tenpence, for which a ſhaft in that Mine bears the name of Tenpenny-Shaft (ſee North-Downs plate). But my readers will wonder more when I declare, that I have known ſeveral hundred tons of Copper Ore wrought and dreſſed for fivepence halfpenny in the pound, at Huel-Virgin Mine: this, however, muſt be underſtood to have been the caſe, when the commodity brought a better price by thirty ℘ cent. than it now bears: which obſervation ſuits with the decreaſed value of Tin as well or more ſo; for it is equally true, that where I have been formerly concerned, as part owner of a Tin-Mine, we have ſet a Pitch to be wrought

for

for three ſixty-fourths of the whole, or three-eighths of one-eighth in the ſtone, before it was made merchantable, by the additional expence of carriage, ſtamping, and dreſſing.

With reſpect to the plan laid down by Miners for calculating the charge, at which they can work this or that Pitch, it is much the ſame as that for ſtoping of ground by the fathom. For inſtance: if a Tin Lode is a three feet Gunnies wide, a fathom in depth and length of that bigneſs will produce fifty kibbals of Lode, which when ſpaled may amount to one hundred ſacks of Tin-ſtuff fit for the ſtamping mill. This, when dreſſed, ſhall produce three hundred weight of white Tin, which they call "being worth three hundred weight of Tin a "hundred;" that is, for every hundred ſacks of Tin-ſtuff, it will yield three hundred weight of Tin-metal, worth, we will ſay, three pounds ⅌ hundred weight, that is, nine pounds. The Tin in the leavings of which (a term that will be more eaſily comprehended, by turning to the chapter upon dreſſing of Tin) at five ſhillings ⅌ hundred weight, or more commonly expreſſed "at fifty ſhillings ⅌ thouſand" or half ton, is fifteeen ſhillings. The Lord's part, dues, or land-dole, is one-fifteenth of the whole, that is to ſay, ſix two-thirds ſacks; the Bounder's or toll part is one-tenth of the remainder nine one-third ſacks—theſe ſixteen ſacks being taken from the hundred, the reſidue becomes eighty-four; worth, at the above calculation, ſeven pounds eleven ſhillings and threepence, and the leavings at fifty ſhillings ⅌ thouſand twelve ſhillings and fourpence—in all for eighty-four ſacks eight pounds three ſhillings and ſeven pence.

	£	s.	d.
Now the charge of working the fathom, is	£1	6	0
Raiſing, ſpaling, and dividing	0	8	0
Filling the ſacks and loading the horſes	0	2	0
Carriage, ſtamping, and dreſſing (the expence of which is different as the Mine is more or leſs diſtant from the mill) we will allow to be only	0	9	0
Carriage to ſmelting-houſe and expence	0	4	0
In all	2	9	0

So that the Tributor muſt have two Doles and three quarters out of nine Doles, to get wages; which two Doles and three quarters are worth two pounds nine ſhillings, according to the above calculation.

Again, if a Tin Lode is only ſix inches big or wide, one fathom may produce twenty ſacks of Tin-ſtuff, worth ſix pounds, at the rate of "a thouſand Tin a hundred;" that is, at the aſſignable quantity of ten hundred weight of Tin-metal for every hundred ſacks of Tin-ſtuff. The Land-dole, or Lord's part, being one-fifteenth, is one ſack and one-third; the toll or Bounder's ſhare, is one-tenth of the remainder, which is one ſack two-thirds and one-fifth. Theſe three ſacks and one-fifth taken from twenty, the remainder is ſixteen and four-fifths of a ſack, value five pounds and ninepence. The leavings at forty ſhillings for ten hundred weight of white Tin (the richeſt Tin generally yields the pooreſt leavings, which will be ſhewn hereafter) will give ſix ſhillings and threepence, which added to five pounds and ninepence make five pounds ſeven ſhillings.

The expence of working the fathom will be	£1	10	0
Raiſing, Spaling, and dividing	0	1	8
Filling the ſacks, loading the horſes, carriage, ſtamping, dreſſing, and ſmelting-houſe expences	0	2	6
In all	1	14	2

The Taker or Tributor muſt, therefore, have three doles out of nine, to get a livelihood.

On the other hand, if a Copper Lode is wrought a three feet Gunnies wide, one foot of which is worth ſaving for Ore; allowing the whole Gunnies to turn up fifty kibbals of ſtuff, ſixteen of them may produce one ton of Copper Ore worth ſix pounds.

Now the expence of working the fathom of Lode would be	£1	10	0
Drawing or raiſing the broken ſtuff or Lode	0	7	0
Dreſſing the Ore at eightpence in the pound	0	4	0
In all	2	1	0

Which divided by ſix, the quotient will be ſix ſhillings and tenpence, the money the Tributor ought to have in the pound ſterling to gain bare wages.

Again,

Again, fuppofing the Lode to be fix inches big or wide, the Gunnies muft be two feet big, and one fathom in length and depth of the Lode, to make a ton of Copper Ore worth twelve pounds.

	£	s.	d.
The expence of digging the fathom	1	7	0
Drawing the broken ftuff thirty-four kibbals	0	5	0
Dreffing the Ore at threepence in the pound	0	3	0
In all	1	15	0

Which being divided by twelve, the quotient will be two fhillings and eleven pence, the money the Tributor ought to have in the pound to earn a living.

CHAP. V.

Of Damps in Mines, and of Levelling and Dialling Mines, Adits, &c.

IN a treatife on the wholefomenefs and unwholefomenefs of air, Mr. Boyle makes it appear, that they depend principally on the impregnation received from fubterraneous effluvia, a caufe generally overlooked; and it is probable, that moft of the difeafes which phyficians call new, are caufed by fubterraneous fteams. In general, though the wholefomenefs of the air in fome places may arife chiefly from the falubrious expirations of fubterraneous bodies, yet is the air depraved in far more places than it is improved, by being impregnated with Mineral emiffions. Indeed among the Minerals known to us, there are many more noxious than wholefome; and the power of the former to do mifchief, is more efficacious than of the latter to do good, as we may guefs by the fmall benefit men receive in point of health by the effluvia of any Mineral or other known Foffil, in comparifon of the great and fudden damage that is often done by the fumes of Mundick, Arfenick, Vitriol, Sulphur, and other deleterious Minerals. (Boyle, Boerhaave). And though thefe Minerals are moftly found in Mines, pits, and other places deep under-ground, yet they are commonly fcattered on the banks of thofe Mines at the furface, in all places productive of Minerals as our county is.

Hence

Hence it may, perhaps, be no difficult matter to ſhew, that an alteration of the common air by an unctuous vapour of the vitriolick kind, raiſed by an unſeaſonable warmth, and too great a proportion of watery and other groſſer particles mixed with it, may be the cauſe of thoſe epidemick diſeaſes, which are uſually called Nervous and Malignant, Bilious and Putrid.

The Mineral effluvium then, acting on the fluids in a degree ſhort of extinguiſhing life, is abſorbed into the habit, infects the blood, and from that minute the whole frame becomes more and more feeble: whence it will be eaſy to deduce all the ſymptoms which accompany a ſlow continual nervous fever. (Huxham).

It is well known, that this contagion in the blood and animal ſpirits will produce in different perſons very different diſorders, though they may juſtly be attributed to one and the ſame cauſe; nay, in the ſame conſtitution, by length of time, and the ſolution of the red blood globules, a ſlow nervous fever will terminate in the highly putrid and malignant: yet the latter may be immediately derived from the ſame ſpring, and ſhall vary only in a vigorous conſtitution with rich blood, or in a weak lax habit and very incompact craſſamentum. Upon the whole, then, it is not ſtrange that thoſe different diſorders are frequently confounded, as the ſame conſtitution of the atmoſphere contributes to both.

I was drawn into the particular conſideration of theſe matters, by our endemick fevers in the ſpring of the year 1773, and my peculiar lot to fall in with thoſe of the worſt kinds: ſo prevalent were they indeed, that I may venture to affirm out of three thouſand inhabitants here, not leſs than half the number were manifeſtly affected in a greater or leſs degree with febrile ſymptoms of the nervous, bilious, or malignant kind; and though not above fourteen perſons died, yet we have many who may lament the effects of thoſe diſorders to the lateſt day of their lives. In the year 1752, nervous and malignant fevers were reckoned mortal in this pariſh, and particularly in families where a ſimilarity of conſtitution equally favoured the production of one diſorder. I then knew three brothers to have died of a putrid malignant fever, out of four which had the diſeaſe; yet theſe men all lived in ſeparate houſes, at a quarter of a mile's diſtance; and had the leaſt intercourſe with each other that ever I obſerved in perſons ſo nearly allied: I take this to be be a great inftance of the efficacy of contagion in one derivative habit of body. Some part of our Mining diftrict is ever molefted by fuch violent fevers: one or other of the parifhes of St. Agnes, Kenwyn, Kea, Redruth, Gwenap, Stithyans, Wendron, Sithney, Breage, Crowan, Gwinear, Camborne, and Illugan, have epidemick fevers always among them.

Mineral exhalations are allowed to be one caufe of contagion, and, Mr. Boyle fays, even of the plague itfelf: my principal defign, therefore, is to prove the obnoxious fituation of our Mine country to thofe dangerous difeafes; and from thence to infer, that they are with us the peculiar production of Mineral effluvia. If this is not the cafe, I fhould like to be informed what occafions thofe diforders to rage with fuch violence among us, and be endemial to our Mining parifhes? Perhaps it may be faid, they are produced by the unwholefome and uncleanly manner of living among the Tinners. But I have known them to originate in the moft cleanly healthy families; nay, it is notorious, that the more regular livers, and more delicate inhabitants of this town, have more generally and powerfully experienced their attacks.

In December 1772, particularly at the time of the poll for a knight of the fhire, we had a warm moift atmofphere for three weeks, without rain, or a currency of air fufficient to blow out a lighted candle. Soon after, nervous and malignant fevers were very rife, and were generated I apprehend by thofe Mineral effluvia, which, in that month, by means of the foregoing conftitution of the atmofphere, were fufpended for a confiderable time, and particularly affected thofe perfons whofe nervous fyftem was very weak and lax, or thofe of quick and lively fenfations; while fuch as were athletick, robuft, and fanguine, generally efcaped their peftilential influence. Again; it was obfervable, that the weather, in December 1774, and in the beginning of January following, was unfeafonably warm, ferene, and mild; the air for three weeks before was fcarcely agitated by one breeze, but continued, all that time, warm, moift, and vapid. The writer then predicted the confequential malignant effects which happened foon after; and he thinks any one may foretel the eventual incidents that muft follow fuch continual unfeafonable weather, in a country teeming with Metals and Minerals. But it is time to come nearer to the point in hand, and to fhew, that we are obnoxious to poifonous Damps underground, notwithftanding the preconceived notion of many to the contrary. If it is poſſible for the ſuperficial Mineral ſteams of our earth to be thus deſtructive among us, how much reaſon have we to conclude, that many inſtantaneous deaths from Damps in the Mines, are more eminently occaſioned by ſuſpended mineralick vapours of the moſt deleterious miaſm.

In thoſe Mines which are replete with Mundick and Copper, and where ſome parts are not ſupplied with a ſufficient current of air to diſperſe the effluvia, I have known ſeveral men and boys periſh in a few months: and though ſome may linger for a longer time, they are generally grieved with nauſeas and reachings to vomit, oppreſſion upon the breaſt, laſſitude and torpor of the limbs, till at laſt the whole habit becomes tabid, and they die hectick or conſumptive.

It is a miſtake, that "Damps in our Corniſh Mines are never "ſo venomous as to be immediately fatal." I have known many inſtances to the contrary; particularly one, in a ſhort Drift, by the ſide of an Adit, which carries a large ſtream of water, a father and ſon, with other perſons, were walking through the Adit, when the ſon ſtepped into this old ſhort Drift, and inſtantly fell down dead: the father on obſerving this, followed the ſon to give him ſuccour, and ſhared the ſame fate: their companions ſeeing this misfortune, avoided the danger, and cautiouſly recovered the bodies for interment. To what leſs cauſe can we attribute this ſudden deſtruction, than to a venomous damp in this particular place; which the famous Grotta dè Cani, ſo named from its mortiferous effects upon dogs and other animals, cannot exceed?

Mr. Jeſſop, in the Philoſophical Tranſactions, obſerves, that there are four ſorts of Damps: the firſt is the ordinary ſort; the ſigns of its approach are the candles burning orbicularly, the flames leſſening by degrees, till they quite go out; and ſhortneſs of breath: ſuch as eſcape ſwooning, receive no great harm thereby; but thoſe that ſwoon away, and eſcape an abſolute ſuffocation, are, upon their firſt recovery, tormented with violent convulſions: the ordinary remedy is to dig a hole in the earth, and lay them on their bellies, with their mouths in it; if that fails, they ſupply them with large quantities of good ale; and if that miſcarries, their caſe is concluded deſperate.

The ſecond ſort of Damps is called the Peaſe Bloſſom Damp, becauſe it is ſaid to ſmell like that bloom: it always happens in the

the ſummer time ; and is obſerved in Mines, that are not infected with any other. It is not reckoned mortal ; but on account thereof, many Mines lie idle for the beſt and moſt profitable ſeaſon of the year, when the ſubterraneous waters are loweſt.

The third is the moſt extraordinary, and moſt peſtilential of all ; and thoſe who pretend to have ſeen it, for it is viſible, deſcribe it thus : In the higheſt part of the roof or backs of large Drifts, which branch out from the Mine or main workings, ſomething round is often ſeen hanging, about the bigneſs of a football, covered with a ſkin of the thickneſs and colour of a cobweb. This, they ſay, if broken by any accident, immediately diſperſes itſelf, and ſuffocates all the company : therefore, to prevent its ill effects, as ſoon as it is obſerved, by the help of a ſtick and long rope, they break it at a diſtance ; after which, the place is well purified by fire, before they venture in again. It is aſſerted, that the ſteam, ariſing from the bodies of the Miners, and from the candles, aſcends into the higheſt part of the Drifts, condenſes there, and in time contracts a film, which at length corrupting, it becomes peſtilential.

The fourth is that vapour, which, touched by a candle, preſently takes fire, giving a report like a gun, and producing the effects of lightning.

Theſe pernicious Damps in Mines, ſhew abundantly, that nature affords inflammable air in ſome caſes ; and we find by experiments, that art can do the ſame, and that, probably, on the ſame principles ; for if you mix Iron filings, oil of vitriol, and water, by the addition of common air it will become inflammable. Sir James Lowther having collected the air of ſome Damps in bladders, preſerved it ſo well, that when brought up to London, it would take fire at the flame of a candle, on letting it out at the orifice of a piece of tobacco pipe. It is well known to all that are verſed in chymical experiments, that moſt Metals emit a great quantity of ſulphureous vapours, during the effervеſcence they undergo in the time of their ſolutions in their reſpective menſtruums : this vapour being received into bladders, in the ſame manner with the natural air of Sir James Lowther, has been found to take fire, in the like manner, on being let out in a ſmall ſtream, and anſwered all the phenomena of the natural kind.

We

We ſhall obſerve that this inflammable air, the condenſed air N° 3, and the Peaſe Bloſſom Damp, are never known in our Corniſh Mines ; but that the fixable air which is readily imitated by a mixture of oil of vitriol, water, and chalk, and extinguiſhes candles, is common to ſome parts of them.

Dr. Conner in his Diſſert. Med. Phyſ. relates a caſe of ſome people digging in a cellar at Paris, for ſuppoſed hidden treaſure: after a few hours working, the maid going down to call her maſter, found them all in their digging poſtures, but dead. The perſon who managed the ſpade, and his attendant who ſhovelled off the earth, were both on foot, and ſeemingly intent on their ſeveral offices : the wife of one of them, as if weary, was ſitting on the ſide of a hopper, and leaning her head on her arm ; and a boy, with his breeches down, was evacuating on the edge of the pit, his eyes fixed on the ground : all of them, in ſhort, in their natural poſtures and actions, with open eyes, and mouths that ſeemed yet to breathe, but ſtiff as ſtatues, and cold as clay.

I have known ſome inſtances in Cornwall ſimilar to this ; and I preſume it has been often the caſe with us, that people have fallen into a pleaſing kind of ſlumber, from which they never awoke : at leaſt I have been told ſo, by ſome who had experienced the approaches of it upon themſelves, and had the fortitude to ſhake off that fatal reverie, into which they had been inſenſibly drawn. In the Mine of North-Downs, a drift end was in driving, where the air was ſcarcely known to be ſcanty : one evening, at the uſual hour of relief, an elderly man, called Bamfield, and a boy, came to the Mine, and went down to their place, from whence the other workmen were juſt come. Some time after the next hour of relief was elapſed, their partners were ſurpriſed that Bamfield and the boy did not come above ground. After waiting a little longer, they went down, and found the boy in a recumbent poſture ; and Bamfield cloſe to the end, ſitting ſtiff upon his breech, with both hands to his forehead, and his elbows reſting on his knees, in a kind of ſleepy nodding attitude ; but both of them cold and ſtiff.

A want of air is indeed ſo frequent, that few of our Shafts or Adits can be driven or ſunk to any conſiderable depth or length, without ſome degree of its ill effects ; but as ſoon as they can conveniently give the Shaft or Adit a free communication of air,

air, they are relieved, and the Damp ceafes. For this purpofe, they fometimes make ufe of a kind of air pipe, which conveys air down to the labourers: at other times, they fink a fide Shaft; and as they go deeper in it, they work holes or drifts, as occafion ferves, from the fide Shaft into that which contains the Damp; and this communication between the two Shafts, gives the air a draft or current. But when this want of air happens at the end of an Adit, as it is very ufual, they ufe thofe methods of fallering, &c. already defcribed, book iii. chap. 3. which fupplies them with air till a new Shaft is funk down upon the end, and holed to the Adit, which gives the men a free refpiration, and liberty of working, till another Shaft is requifite. Sometimes they are annoyed with Damps in dry fhallow pits, which are probably caufed by noxious thick vapours that are emitted out of the pores of the earth; at other times, the Damps feem to proceed from the corrupt effluvia of ftagnating waters, that have lain a long time in the Lode or a Shaft. Both thefe Damps are fo thick and heavy, that they kill and fubdue the vivifying fpirit of the air; fo that for want of a frefh fupply, the Miners cannot continue long under-ground.

Befides the finking of Shafts and putting down air pipes or the like, there are fome other things which help to fet the bad air in motion, and fo ferve in part to difpel the grofs unwholefome vapours: thus, the drawing of water out of a Shaft, and the motion of the tackle, or the water that runs in an Adit, will help to diffipate the bad air; alfo, if faggots on fire or any burning fewel be thrown into a fuffocating Shaft, it will rarify the bad air for a while, and by the admiffion of frefh air the men may work fome time longer, till the Damp condenfes and gets to a head again.

Damps are generally moft common in fummer. About the dog-days we obferve they are not fo eafily remedied by air pipes and fallers, as in the other months; becaufe the earth and atmofphere are greatly warmed by the folar rays, and the air itfelf is fo very calm and ferene, that for want of a due agitation thereof, Damps are occafionally more or lefs, from thefe circumftances of the feafon, and very often in thofe places which are not affected by them at other times of the year. When they blaft rocks by gunpowder they are frequently obliged to come above ground, and wait fome hours before they can venture down again, to work and clear away the fhattered ftones. Linden fays, he is fure, the fmoke of the gunpowder with the heat will diſſolve and raiſe up in fumes a great deal of the Terra Mercurialis Metallorum, which will occaſion a poiſonous Damp; and therefore it is neceſſary that the gunpowder ſhould be mixed with ſomething that will prevent the ſolution, and ſheath and envelope the acid particles of the ſalt petre and brimſtone. Any unctuous or oily body will do it; and will be ſo far from being detrimental to the blaſting, that it will be rather of ſervice to it, becauſe it will add to the ſtrength of the gunpowder, and make it do more execution than if it was uſed alone; and not only hinder its ſmoke from occaſioning any noxious Damps, but deſtroy the naturally poiſonous qualities that lodge in the cavities of the Mine. The mixture that I would uſe with the gunpowder, is as follows:

Take one pound of gunpowder, one ounce of oil of turpentine, two drachms of camphor, and half a drachm of borax. Mix them well in a marble mortar, and they will be fit for immediate uſe.

Dr. Brown in his Travels and Obſervations on the Mines of Hungary, a book in which are many excellent remarks on Mines and Minerals, and highly uſeful to all concerned therein; ſays, that where an air Shaft cannot be conveniently ſunk, the Germans apply a large bellows with pipes of lead or leather to throw in air to the workmen. In the year 1696 this was put in practice, for the firſt time, in St. George's Adit in Goon-Laz in St. Agnes, where by reaſon of the great depth, (at leaſt forty fathoms from graſs) it was impoſſible to ſink a Shaft, and to have ſucceeded without this or ſome other invention to convey air. It has been ſince tried in other places with the like ſucceſs, as I am informed, for I never ſaw it put in practice myſelf; indeed it was invented by the lord St. Albans, before the time of Brown's travels, and practiſed in Wales by his ſervant Thomas Buſhet, Eſq; (Fuller's Worthies in Wales, p. 4).

Now as we ſee ſome Adits muſt have a great many Shafts to convey air to the workmen, as well as to ſave the expence and trouble of rolling the broken work a great way back to the laſt ſhaft; ſo it is neceſſary likewiſe for them to underſtand the uſe of a dial compaſs, to direct them where to put down ſuch Shafts as are wanted in their right places. Dialling is requiſite in almoſt every Shaft they ſink on an Adit, or elſe they may dig out of the way to no purpoſe; and when they work out of their right way in an Adit, it corrects and rectifies their miſtake. Indeed,

Indeed, without Dialling, they would often inſenſibly go aſtray from the line they had juſt begun or proceeded in, and inſtead of working forwards towards the Mine, they may inadvertently drive in a contrary direction. It is true, a candle is a great guide to the labourers; for if they work ſo ſtraight as to ſee a lighted candle that is placed where they began, they need fear no error, in caſe they began right; but if they once chance to work awry, and loſe ſight of the candle, it is no longer of any ſervice for keeping them in a ſtraight line.

This art of Dialling is alſo very uſeful, in directing them where to ſink a Shaft exactly on any part or end in a Mine; and where to ſink a Shaft for cutting the Lode, or Gunnies upon the underlie, which Shaft in ſuch caſe is called an underlier. It is equally neceſſary in other reſpects for meaſuring the ground to the extent of this or that place or limit; for want of which knowledge, one ſet or party of adventurers may injure another, by encroaching on their property. Hence I apprehend, that Dialling, well and truly underſtood, is of no little conſequence to the different neighbouring Lords and Bounders; otherwiſe it would be no difficult matter, for the adventurers to drive and dig promiſcuouſly, into the ſeveral lands and properties of diſtinct and ſeparate perſons, whereby great confuſion and loſs might enſue to ſome or other of them; which this art effectually prevents, by aſcertaining the juſt limits of each, and fixing their proper boundaries, through means of a line hung perpendicularly under-ground, with more exactneſs than is commonly ſettled by hedges, ditches, ſtones, or land-marks above-ground. Nothing can be more exact than a limitation of property, by the breadth of a ſingle line; and yet I really believe a difference of one inch, in ſome very rich Mines, might make a difference of ſeveral pounds to the different proprietors.

This laying out a traverſe or meaſure under-ground, cannot, however, be very accurate with thoſe, who take no account of the points or angles of the compaſs, but in lieu thereof, chalk the bearing of the line they meaſure with, on the board the compaſs lies in; for if they are not exceedingly careful and preciſe in their operations, they may commit almoſt unpardonable and irretrievable blunders: yet formerly, before penmanſhip and figures were ſo generally underſtood and practiſed among the common Tinners, as they are at preſent, moſt of our Mines and Adits were dialled for in this manner.

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The inſtruments uſed for Dialling are, a compaſs without a gnomon or ſtyle, but a center pin projecting from the middle of the compaſs to loop a line to, or ſtick a candle upon, fixed in a box exactly true and level with its ſurface, about ſix, eight, or nine inches ſquare, nicely glazed with ſtrong white glaſs, and a cover ſuitable to it hung ſquare and level with the upper part of the inſtrument: a twenty-four inch gauge or two feet rule, and a ſtring or ſmall cord with a plummet at the end of it: a little ſtool, to place the dial horizontally: and pegs and pins of wood, a piece of chalk, and pen, ink, and paper.

The method of Dialling an Adit, in order to ſink a new Shaft down-right upon its end, is this: firſt they drop a line or plummet down in their laſt Shaft, in the middle of the breadth of the Adit; a man that ſtands at the mouth of the Shaft above-ground, marks the place of the line there on a deal board flung acroſs the Shaft, while the perſon who dials under-ground obſerves the ſpot on which the plummet falls in the Adit; there he holds the end of a ſmall cord in his hand, while another perſon carries the other part with him, as far as he can go in a ſtraight line, without loſing ſight of the Dialler's candle: the cord being drawn ſtraight and tight, he holds it in the midſt of the breadth of the Adit, while the Dialler fixes the ſide of the compaſs accurately parallel with the line, and notes the bearing of the compaſs upon paper; and meaſuring the length of the cord to the other man's hand, he notes the length thereof on paper likewiſe. In the ſame manner the Dialler takes his ſecond meaſurement or draft, by ſetting his line and compaſs afreſh, and proceeding as before, till he comes to the middle breadth of the Adit-end. This being done, he comes up from under-ground, obſerves the place of the plummet line above at the Shaft, where he ſets his compaſs, and lays off the very ſame traverſe at graſs which he took underneath; at the end of which, a new Shaft muſt be put down, directly on the Adit-end. In caſe there are one, two, or many more angles or turns in the Adit, the compaſs muſt be reſet at each of them, and their bearings or lengths meaſured, and taken down on paper; which will exactly anſwer to an experimental Dialler, by laying out the ſame traverſe above-ground, as hinted before.

Some, inſtead of meaſuring each draft or length of cord, untwiſt it, and faſten pins of wood numbered 1, 2, 3, and ſo on, at the noted places, which may ſerve the purpoſe; but I think

think it more regular to take the bearings of the compafs on paper, and alfo the refpective lengths, in columns oppofite each other. It is alfo to be remembered, that if the cord be wet in meafuring under-ground, it ought to be the fame in meafuring at grafs, and vice verfa; otherwife it may caufe no fmall error, becaufe when wet it fhrinks, and lengthens when dry.

To know the exact depth of an underlying Shaft, and a Winds, and how far a Gunnies may extend from the bottom of the Shaft to the brace of the Winds; you muft order fome one to defcend into the Shaft: then let your ftring down in the manner of a plumb, through a hole made in a deal board, laid acrofs the brace of the windlafs, taking the moft convenient place where it will go deepeft, and not touch the fides of the Shaft. Where it touches at the bottom or underlying wall of the Shaft, there let a mark be made with a pick-axe. As the ftring hangs in the Shaft, apply the fide of your dial to it, as horizontally and directly acrofs the Gunnies or excavated Lode (which is here in the Shaft, or the Shaft in the Lode, which you pleafe) as you poffibly can, obferving what degree the needle ftands on, which we will fuppofe to be fifty-two. This degree you muft keep for your fquare. Then take up the ftring and meafure it by the two feet rule, noting the length of the ftring on paper in rules and inches, under the word depth, as you are defired to obferve in the following example. You may fuppofe this depth to meafure twenty-four rules, which you muft fet down, and the degree fifty-two directly againft it.

Then go down to the bottom of the Shaft, where the mark was made. From hence you may begin to take the underlie of the Shaft, by laying a line horizontally acrofs the Shaft from the mark, to the oppofite fide, roof, or hanging wall, of the Gunnies or excavated Lode; applying your dial to the fide of the line, or moving them up and down together, till you fee the needle ftand upon your fquare degree fifty-two. Then drop your line and plummet from the roof or hanging wall of the Shaft, till they touch the fide or bottom wall, as you did before from the brace of the Shaft; and where the plummet touches at the bottom wall of the Shaft, make another mark. You muft then meafure the breadth of the Shaft from the bottom of the laft plumb, to the oppofite or hanging wall, which we will fuppofe to be one rule twenty inches. Pull up the line, and meafure its length from the rule to the mark below. This meafure muft be noted under the word depth; becaufe, it is

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the fecond dropping or plumbing of the Shaft; and we will call it fixteen rules. This being noted under Depth, fifty-two under Degree, and one rule two inches under the word Length, as in the following example; you muft defcend to the place where the laft mark was made, and lay the line horizontally acrofs the Shaft from the mark to the oppofite fide or wall, applying your dial to the fide of the line, moving them up and down together, as you did before, till you fee the needle ftand upon your degree fifty-two. The line and dial lying thus horizontally by the fide of each other, drop your line as far as it will go before the plummet touches the bottom wall of the Shaft, holding the line at the hanging wall where you will fee it will go deepeft, and not touch the fides. Here make another mark, where the plummet touches; which done, pull up your ftring, and meafure this depth, meafuring likewife the breadth of the Shaft where you held it: fuppofe you fay, depth twenty-fix rules fourteen inches, degree fifty-two, and length or breadth two rules four inches. (See the example following). Here, the Shaft appears to be eight inches wider than it was, eight fathoms, five feet, and two inches higher up at the bottom of the laft drop or plumb; a circumftance very common in all Shafts underlying with the Lode, as in fuch places the breadth of a Shaft muft depend upon the width of the Lode, if it is worth the breaking. But to proceed.

In order to make a third drop in the Shaft, before we arrive to the bottom of it (which I chufe to do, that it may appear in a more practical light, as fome Shafts underlie fo faft, as to require a great many drafts before the bottom can be dialled, and its pofition and depth afcertained) we will defcend to the mark laft made, where the Shaft is two rules four inches, or four feet four inches wide; and ftretch a line from the mark horizontally acrofs the Shaft to the oppofite wall, applying the fide of the dial as before till the needle ftands on the degree fifty-two. The line muft then be dropped till the plummet touches the bottom of the Shaft, clear from any contact with its fides. Here, at the plummet, a mark muft be made alfo. Obferving the breadth of the Shaft at the horizontal line, take up your plumb, and meafure how many rules it is; fay twenty-eight rules twenty-two inches depth, fifty-two degrees; and the number of inches acrofs the Shaft, fay one rule twelve inches, length, or breadth.

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The Shaft being now dialled to the bottom, go down there, and hold the Dial where the mark was made, rectifying the needle to the degree fifty-two. It is many times the cafe, that a fhort crofs length muft be taken, to gain room or liberty to take a long length in a Drift or Gunnies. I will fuppofe it muft be done here; and it is very eafy to be done, as before, in taking the breadth of the Shaft, by applying the ftring or line parallel to the fide of the Dial. At the end of the fhort length, meafure how many rules and inches it is, and fet it down; which you may fuppofe here, one rule ten inches; degree fifty-two.

This fhort crofs length being taken, you proceed to take a long length, upon the courfe of the Lode or Gunnies, towards the brace of your Winds or under-ground Shaft, by giving your affiftant the end of the line, and directing him to go back into the Drift or Gunnies as far as he can, till the ftring touches fomewhere on the fide of the Drift, yourfelf holding, at the fame time, one end of the line, in the mark you made at the end of the fhort length. The ftring muft touch no where betwixt you and your affiftant. Apply the fide of your Dial to the ftring exactly parallel one with the other: then take the degree the needle ftands on (no matter which it is) fay thirty-fix; and let him that is at the other end of the line drop a ftone to the bottom of the Drift. Meafure the ftring in rules and inches, which you may fuppofe to be twenty-two rules eight inches, degree thirty-fix. Proceed onwards to the place where the ftone was dropped; and if there is occafion to take another fhort length or draft, which we will fuppofe, lay the ftring acrofs as before, one end being in the mark, rectifying the needle to fifty-two; which being done, fet down the degree, and this fhort draft over againft it. Say only ten inches, where you make a mark as before.

This fhort length being taken, you are now again at liberty to take a long one forwards in the Drift or Gunnies; then let your affiftant take the ftring, and go as far backwards as he can, till the ftring almoft touches fomewhere in the middle on the fide: thus, (holding one end in the mark you made laft, when you took the fhort length) ftretch the line tight, apply the fide of the Dial to the ftring, and take the degree the needle ftands on, viz. thirty-fix: fet down the degree on paper, and bid him make a mark at the end. Meafure the line, and note the length directly againft the degree (thirty-fix) you took laft, which

which may be twenty-four rules fourteen inches to the middle of the brace of the Winds.

The next operation is to take the exact depth and underlie of the Winds, which muft be performed by rectifying the needle upon degree fifty-two, the old fquare; but if there be any need to take a fhort length to gain a greater liberty to plumb the Winds, you muft take it. Your affiftant defcending into the Winds, let the ftring down after him, and where it touches on the fide or underlie, let him make a mark; yourfelf holding a line or one end of your rule in the mark that was made at the Wind's brace, lay the fide of the rule or line parallel to the fide of the Dial, and rectify the needle till it ftands at degree fifty-two. Note this fhort length on paper, which you may here fuppofe to be eight inches. Meafure your line; fay twenty-eight rules fix inches; fet it down, and the degree fifty-two alfo: which being done, go down to the laft mark, and becaufe the Winds ftill underlies, put one end of a line in that mark, and ftretch the other horizontally acrofs the Winds to the hanging wall, with the edge of the Dial exactly parallel to its fide, and rectify the needle till it ftands upon the degree fifty-two. Thus let the plummet down from the hanging wall to the bottom of the Winds, if it will not touch the fides betwixt you and the bottom; fet down the length or breadth of the Winds which is two rules, degree fifty-two. Make another mark at the bottom of the Winds where the plummet touched, and meafure the depth of this laft dropping or plumbing, which you may fuppofe thirty rules two inches: and thus you have finifhed the plumbing of your Winds.

If you have any further to dial, obferve to take your fquare degree, where there is this occafion; for if you omit taking your fquare, you will lofe yourfelf in the exactnefs of the grounds length, fometimes making it more, and fometimes lefs than really it is, and fo commit very great blunders when you come to dial it above-ground. You muft alfo take care, that you hold your line exactly level, when you take your crofs lengths in drifts, and by that means you will have the exact depth. You muft likewife obferve, that your rule or line lie parallel with the edge of your Dial, that is, equal, at both ends; or elfe you will mifs in taking the true degree. Remember, that under-ground, the Dial is guided by the line; but, above-ground, the line is guided by the Dial. The following example of the foregoing drafts, I truft, will ferve to inform

inform the reader, of the manner in which they are noted on paper.

Depth		Degrees	Length	
Rules	Inches		Rules	Inches
24	—	52	—	—
16	—	52	1	20
26	14	52	2	4
28	22	52	1	12
—	—	52	1	10
—	—	36	22	8
—	—	52	—	10
—	—	36	24	14
28	6	52	—	8
30	2	52	2	—

Here you fee the depth is one hundred and fifty-three rules, one foot, eight inches. The rule containing two feet, make in all three hundred and feven feet, and eight inches, for the depth of the Shaft and Winds; which, by reduction, make fifty-one fathoms, one foot, eight inches, for the true depth of the Mine at that place.

If you chufe to know how much your Shaft and Winds underlie, you muft add together the lengths that ftand againft your fquare degree fifty-two; in all feven rules, fixty-four inches, which, by reduction, make three fathoms, one foot, four inches, the exact underlie of your Shaft and Winds.

To know the length you have driven in the Mine, without laying it forth above, you muft add up the rules and inches that ftand under the word length, againft your bye degree (thirty-fix) which in this example are only two drafts, viz. forty-fix rules, twenty-two inches, equal to fifteen fathoms, three feet, ten inches, which you have driven in the Mine.

But if you defign to dial and lay it out above-ground, fet the Dial upon the degree fifty-two; and looking in your notes for one rule twenty inches, which was the firft length, put one end of the rule to the hole in the deal board (page) flung acrofs the Shaft-brace, where you held the ftring, when you began to plumb the Shaft. The rule lying to the fide of the Dial, and

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the needle being rectified to the degree fifty-two, make a mark at one rule twenty inches upon the ground; and thus you have done the firft degree. In like manner you may do all the reft, if you go over thefe degrees fingly, one by one; but as here are feveral fquare degrees (fifty-two) before you come to any bye one, which goes upon the courfe of the Lode, you may take all thefe fquare degrees together, firft adding their lengths together, to know how many inches and rules they are.

The lengths oppofite the fecond, third, fourth, and fifth dergees (fifty-two) are equal to three rules forty-fix inches, which by reduction amount to two fathoms, one foot, ten inches, the exact underlie of your Shaft; therefore if you firft meafure out fo much of your ftring or line, and the needle is rectified to fifty-two, bid your affiftant make a mark there: thus you take all the four degrees together and find the mark at grafs, which he made at the bottom of the Shaft. Go to the mark your affiftant made, and look to your notes for your next length, meafuring out fo much upon your cord, viz. twenty-two rules eight inches; then let him go forward with one end, and caufe fome one to hold the other end in the mark he made laft: look to your notes for your degree over againft that length, which is thirty-fix, and rectify your needle to it; let him that has the plummet end of the line, bring the ftring to the fide of the Dial, yourfelf ftanding at fome diftance from him that holds the other end in the mark. The ftring lying exactly even with the fide of the Dial, and the needle ftanding upon the bye degree thirty-fix, bid him make a mark at the end of the plummet, and fo you have done that length.

Now go to your laft mark, and put one end of your rule to it, and fet the needle upon fifty-two, laying the edge of the rule parallel to the fide of the Dial. This length being but ten inches, make a mark there.

Look into your notes for your next length, which is twenty-four rules fourteen inches: meafure this out, and let your affiftant go on with the ftring, caufing the other end to be held in the laft mark. Set the needle upon thirty-fix, the degree oppofite that length; apply the line exactly parallel to the fide of the Dial and ftretch it tight. At the plummet end of the ftring make a mark, which finifhes another length. Laftly, becaufe the other two lengths are both to be taken upon one degree, and there being no other bye degree between them, you

you may add the lengths together, and take them at once, which are two rules and eight inches, the needle ſtanding upon the degree fifty-two. The end hereof is the place at graſs, directly over the mark you made at the bottom of the Winds. Here, if there is a neceſſity for it, or it is worth your trouble and expence, you may ſink a new Shaft down-right upon the bottom of the Winds, which you may as infallibly depend upon performing, as on any the moſt facile tranſaction in Mining. No one thing is more commonly done; it being often of the laſt importance to ſink down a new Shaft, and thereby ſave the charge of drawing the work by a double draft. It is not always requiſite to ſink a new Shaft, directly on the Winds; but whenever it is thought ſo, the undertakers muſt firſt dial underground and afterwards at graſs, before they can preſume to ſink a perpendicular Shaft upon the Winds bottom.

Now, to know whether you have dialled this exactly or not, without going over it again, add all your ſquare ſhort lengths oppoſite the degree fifty-two together: the ſum will be nine rules, ſixteen inches; which, by reduction, make three fathoms, one foot, four inches, the exact declination or underlie of your Lode in the Shaft and Winds, from the brace of the former to the bottom of the latter at fifty-one fathoms, one foot, eight inches, the depth of the Mine or Lode in that place. Again, if you chuſe to aſcertain the average underlie of the Lode, for one fathom with the other, you muſt work the above drafts by the rule of three direct; by which it will appear, that for every fathom the Lode has been wrought in perpendicular depth, its inclination or underlie is four inches and a half. This underlie is very ſmall and ſcarcely merits the name in Cornwall, where frequently our Lodes underlie a fathom in a fathom, and ſeldom leſs than two feet in a fathom. Indeed, ſome few Lodes go down in form of a Zig-Zag; and by that means, at a great depth, deviate from a perpendicular very little from the place where they firſt begin to ſink: but this is very rare; and though it may ſave coſt in not ſinking many underliers and winds, yet the conveniency is over ballanced by having a leſs quantity of Mineral in a given perpendicular Lode, than in that which underlies one half in the other. That is, a Lode that underlies three feet to the right or left from a perpendicular, will meaſure nine feet in depth for every ſix of a central tendency.

But to proceed: in laying out the drafts upon the ſurface, you muſt next add up the lengths you took upon the courſe or run

run of the Lode, which were but two; viz. twenty-two rules, eight inches, and twenty-four rules, fourteen inches, in all, forty-ſix rules and twenty-two inches; which, by reduction, are equal to fifteen fathoms, three feet, ten inches: meaſure theſe out with your rule and line, and give your plummet to the aſſiſtant, to go on with the ſuppoſed run of the Lode, cauſing ſome one to hold the other end at the board upon the Shaft brace, where you firſt began to plumb: then go to the middle of the ſtring, and ſetting the needle upon the degree thirty-ſix, apply the line exactly parallel to the ſide of the Dial, and bid the aſſiſtant make a mark at the end: go to this end or mark, and meaſure out your ſquare lengths, which in all are three fathoms, one foot, four inches: then give your aſſiſtant the end, holding the other end in the mark; ſet the needle upon fifty-two, and bid him apply the line exactly parallel with the box, and make his mark. If this mark hit that you made, when you dialled it before, you have done the work exactly; otherwiſe, you have committed ſome blunder, and ought to try it over again: for this rule always holds true when you take ſquare lengths, and your lengths forward, on the courſe of the Lode or any way, by one degree; as you here took thirty-ſix for your degree.

Many more examples in Dialling might be given, ſuch as, to dial Shafts and Winds that underlie and beat into the end; to dial in a Gunnies with many croſs drifts and turnings, and afterwards to ſquare the ſame at graſs, &c.: but as they are already given in Houghton's Rara Avis, and Hardy's Miner's Guide, and as one hour's converſation with practical Miners will illuſtrate the ſubject better than a week's reading, I ſhall conclude what I have ſaid on it, with this ſingle remark, that the crude, goſſany, ferruginous Ores in the Mines, have no influence on the needle of the compaſs: I have often found, that even the magnet or loadſtone will not attract pure Iron Ore (much leſs the ferruginous Ores of other Metals) till they have undergone the fire, by a calcining heat, or ſome other proceſs; otherwiſe, there could be no poſſibility of Dialling moſt Copper Mines, becauſe they commonly abound with much Iron (Goſſan) in Copper Ores.

The other branch of Dialling, is properly ſtiled Levelling; which is an operation to find the inequality, aſcent, and deſcent, of any ground or hill. Hence it is of great uſe for all aqueducts to towns, houſes, ponds, mills, &c. and particularly in Mining, either

either to bring a water courfe to a Mine, in order to erect an engine, or elfe to find how deep an intended adit will be from or to a prefixed or given place. But as the rules of this art are fully laid down in books that treat on land furveying, I need not dwell on it here; efpecially as the two authors above mentioned have defcribed its ufe and application to our fubject. Neither is it neceffary to defcribe the feveral inftruments and improvements that have from time to time been made and ufed in Levelling, fince the Miners, inftead of the true Levelling inftruments, called the air level, or fpirit level, commonly fubftitute (though not to their credit, for the beft may be had at little expence) a water level of their own conftruction; which is generally a clumfy inftrument in form of a fmall narrow trough, an inch wide, and three feet long, planed very exact and true.

To find the fall or declination of the ground, they lay this Levelling inftrument on the higheft part of the ground they are about to level or meafure, and by pouring water into the trough, they eafily perceive when it lies truly horizontal, and then they proceed in the fame manner that is practifed by others who ufe the air level. But when a Mine lies on a fteep hill, and there is room for a proper ftation below for taking a juft obfervation by a quadrant of altitude, then the height of the hill (which is the fame as the level or depth of the adit at the Mine) may be eafily found by the rules of altimetry. The theory of thefe operations, however, is not confidered by the Miners; neither is a fmall error difcoverable, becaufe they feldom level any great length of ground at one time, and content themfelves with the common manual operations.

Dr. Halley fuggefted a new way of Levelling which is wholly performed by the barometer, in which the mercury is found to be fufpended to fo much the lefs height, as the place is further remote from the center of the earth. Hence it follows, that the different height of the mercury in two places gives the difference of level. Mr. Derham found, from fome obfervations at the top and bottom of the monument in London, that the mercury fell one-tenth of an inch at every eighty-two feet of perpendicular afcent, when the mercury was at thirty inches. Dr. Halley allows of one-tenth of an inch for every thirty yards; and confidering how accurately barometers are now made, he thinks they are fufficiently exact to take Levels for the conveyance of water, and lefs liable to errors than the common Levels.

Some years ſince, the reverend Mr. John Pickering, Mr. R. Phillips, Mr. Waltire a travelling lecturer on philoſophy, and myſelf, took the altitude of the higheſt eminence of the celebrated Druids hill called Carn Brea, by one of Mr. Waltire's beſt barometers; when we made the utmoſt perpendicular height, at the luſtration rock baſons, three hundred and ſixty feet or ſixty fathoms from the bottom of Redruth town. Nevertheleſs, one great obſtacle to this way of menſuration in our county, ariſes from the ſudden and frequent changes of our atmoſphere, which muſt influence the mercury, and cauſe ſome difference between the ſpot of departure, and the place of deſtination, in proportion as the atmoſphere alters; ſo that this method can be uſed only in clear, ſerene, and ſettled weather.

BOOK IV.

CHAP. I.

The Method of Sampling and Vanning of Tin-ſtuff, with the Stamping, Burning or Calcining, and Dreſſing the ſame; with the Manner of Dreſſing the Leavings, Loobs, &c.

TIN-STUFF that lies by the ſide of the Shaft, when it becomes a great heap, or if it otherwiſe ſuits the humour of the concerned, is firſt ſpalled or broken to the ſize of a man's fiſt or leſs, by which the moſt indifferent parts are ſeparated and ſorted from the beſt; ſo that perhaps not more than one half of a large heap may be reſerved for dividing and ſtamping. After the Tin-ſtuff is thus culled, and properly ſized, it is divided out in ſmaller heaps by meaſure of a hand-barrow, that uſually contains a ſack and a half, or eighteen gallons. Theſe ſhares, which they term Doles, are parcelled out into ſo many different heaps on any the moſt adjacent parts of the field, ſometimes to the great prejudice of the huſbandman, who is not conſidered for his damage by the lord of the ſoil, or the owners of the Mine. The method and number of Doles, into which Tin-ſtuff is frequently divided, may be ſeen in book iii. chap. iv. The parcels being laid forth, lots are caſt; and then every parcel has a diſtinct mark laid on it, with one, two, or three ſtones; and ſometimes a bit of ſtick with the initials of the proprietor's name, or a turf laid on the middle of the Dole. When theſe marks are fixed, the Doles may continue there unmoleſted for any length of time: the property is ſettled; and no one, but the right owner, may add or take from it.

The Doles which are deſigned for ſale, are very accurately meaſured; for as the barrows are carried off for their reſpective diviſions, one perſon, who is the reckoner, keeps an account by making a notch in a ſtick for every barrow; and if there be an odd one left, it is equally divided by the gallon, the ſhovel, and, when it is rich, even by the handful. The Doles being divided, they proceed to caſt lots for that which ſhall be ſampled.

ſampled. This Dole being turned over, equally levelled and mixed, is then divided by a man with his ſhovel, into two equal parts, taking a little of the Tin-ſtuff from one end to the other of each of thoſe parts to the amount of ſome gallons if the Dole is pretty large. This quantum is bruiſed down by large ſledges to the ſize of an hazle nut, then equally levelled and divided into four parts, two oppoſite quarters of which are ſelected and bruiſed over again to a ſmaller ſize. Theſe reductions and ſmaller diviſions are repeated again and again ad libitum; till the quantity deſigned for ſampling, is well mixed, and made as fine as common ſand; when each ſampler fills his little canvas bag with it, and proceeds to a trial of its value by water, in the following manner.

To make a rough gueſs or coarſe eſſay, the ſampler takes a handful of it, and waſhes it on a ſhovel, till the impure earthy parts are carried off by the water from its ſides. The more ſtony, ſolid, heavy particles being left behind, they are bruiſed by an aſſiſtant, with a ſledge on the ſhovel, till the whole aſſumes the appearance of mud. This is waſhed again, till it loſes its muddy aſpect; when by a peculiar motion of the ſhovel not to be deſcribed, the metallick particles are collected together on the fore part or point of it. By repeating theſe bruiſings, waſhings, and motions, it becomes clean black Tin, fit for the ſmelting furnace. This is called a Van (from the French word Avant, foremoſt, as I apprehend) it being thrown forth upon the point of the ſhovel, by the dexterity of the ſample-trier. After the Tin is thus made clean to his mind, he dries it; and if it be as much black Tin as will entirely cover a good ſhilling, or rather if it is the weight of a ſhilling, he terms it a Shilling Van, which is not rich; but if the Van will cover or equal the weight of a crown piece, it is good Tin-ſtuff, and is termed a Crown Van. Now they ſay, the Shilling Van will produce one hundred groſs or avordupois weight of block or white Tin; and the Crown Van will yield five hundred weight of block Tin, for every hundred ſacks in meaſure, of the reſpective Doles that the ſample or Van is taken from, and ſo proportionally on, to the richeſt Tin-ſtuff called Scove, which is reckoned ten thouſand of white Tin-metal ℘ every hundred ſacks; or in other words, it will produce one hundred hundred weight of Tin-metal, for each hundred ſacks of Tin-ſtuff; yet there is none near ſo rich as this in any quantity, except a particular ſtone or lump.

But

But a meaſure of a wine half pint is much more exact and true than a handful, to form a judgment from; though the handful be accounted a half pint. The manœuvre is alſo more nice and true, by uſing a large ſhovel, and taking off the ſized Tin from time to time on another ſhovel, and ſo proceeding till all the Tin is reduced clean and to a proper ſize. When this is done, dry the Van in a ſhovel upon the fire; then take it off and weigh it in a money ſcales by pennyweights and grains: for every pennyweight and half the Van weighs, the produce will be one hundred weight of black Tin for every hundred ſacks of Tin-ſtuff; and ſo on in due equation: three pennyweights is equal to two hundred weight; ſix pennyweights to four hundred weight; twelve pennyweights to eight hundred weight; fifteen pennyweights to ten hundred weight; or, as they term it, a thouſand of black Tin a hundred, i. e. for every hundred ſacks of Tin-ſtuff: and if it be Tin worth ten for twenty, or one for two, then the Tin-ſtuff is valued at five hundred weight of block or white Tin, for every hundred ſacks. If the Tin be worth twelve for twenty, the ſtuff is valued at ſix hundred weight of white Tin a hundred; or if it be worth only eight for twenty, it is only valued at four hundred weight of white Tin a hundred; and ſo if the metallick quantity of the Tin be more or leſs, it muſt be accounted for after that manner.

This black Tin is rather of a liver colour, though called black in contradiſtinction from white Tin, or the Metal produced from this black Tin Ore. It is very ponderous; for, in a general way, it may be computed to hold one half clean Metal, and ſome of it will produce thirteen, nay even fourteen parts in twenty; whence the term of ſo much white Tin for twenty of black Tin, that is, eight for twenty; ten for twenty, which is the ſame as one for two; twelve for twenty, and ſo on, be it more or leſs given for Metal; in the knowledge of which the ſample-triers or Tin-dreſſers are very expert, without the uſe of crucible and furnace. Thus if the Van of one hundred ſacks of Tin-ſtuff weighs ſix pennyweights, being four hundred weight of black Tin at twelve for twenty, the white Tin or Metal muſt be two hundred weight, one quarter, ſixteen pounds.

In the preceding manner, they form a near conjecture of the quantity of white Tin that their work or Doles of Tin-ſtuff will produce at the ſmelting-houſe, when it is dreſſed, and brought into black Tin. But if the black Tin is infected with any bad brood or mixture, as Mock-lead, Copper, or Mundick, after

 the

the Van is bruifed fine and wafhed, they lay the fhovel over the fire, and burn the black Tin, continually ftirring it till it fmokes no more. Laftly, they wafh it again on the fhovel, and fo the brood is carried off by the water, it becoming light by being burnt; for when black Tin is calcined or burned, it ftill retains its fpecifick gravity; but Copper, Lead, and other crude Minerals, become much lighter by torrefaction, and are eafily feparated from the Tin by water.

It fhould be obferved, that each fack ought to hold twelve gallons of Tin-ftuff, though they often hold but nine or ten; which want of meafure, when known, fhould be taken into confideration by the Tin buyer.

Now, whoever intends to buy a quantity of Tin-ftuff, either for profit in trade, or merely for the fake of employing his ftamping mills, horfes, and labourers; when his adventure Tin-ftuff falls fhort, which is very commonly the cafe, he muft not give the value of its full produce, without deducting what is called the returning charges, that is, the carrying, ftamping, and dreffing thereof. On the other hand, the reader muft be apprifed, that the value of Tin-ftuff, is fhort of its intrinfick worth by the Van only; for in the dreffing and management of Tin by ftamping, &c. there are two forts of black Tin to be obtained, viz. the crop and rough, or the crop and leavings of Tin. The firft is the prime Tin, immediately feparable from the bafer parts by its fuperior weight and richnefs; the latter is that which is carried off, and mixed with the lighter earthy parts, by its being under fize, and therefore more fufceptible of the force and impreffion of a determinate ftream of water. Such Tin being compofed of the moft flimy moleculæ, as well as of the larger rough grains, which get through the greater fized holes of the ftamping-mill grate, have very little Tin in them, and muft therefore undergo another treatment to get out and cleanfe the Tin. This being called the leavings, muft be accounted for and valued in addition to the crop Tin, in proportion to the denfe or lax confiftence of the Tin-ftuff and the fpecifick granules or minutiæ of the Tin Ore in the ftone. All this depends upon the experienced judgment of the Tin-dreffer; and it is fo difficult and various a fubject, that a man fimply a theorift in the matter, cannot lay down a certain rule on which another can abfolutely depend. The cuftomary valuation is, by fetting a price upon the leavings of this or that Tin-ftuff, according to fo much the ten hundred weight or thoufand

thoufand it makes in crop Tin, from fifty ſhillings to five pounds ℘ thoufand for the leavings. Hence it follows, that the leavings of fome Tin-ſtuff will more than pay the returning charges; but whenever the leavings are rich enough to pay thofe incumbrances, they pronounce fuch Tin-ſtuff to be "Tin in the "Bal;" that is, to be worth four, five, or fix hundred of white Tin ℘ hundred facks by the Van, free of all cofts and charges, which the leavings will exonerate.

All things being well confidered, we may conclude, by trying the fample, how to fize a parcel of Tin-ſtuff by fuiting it with a grate or holed plate, adapted to the natural grain of the Tin, which is one of the principal articles in dreffing; but of this in its place. Mean while let us obferve that the dreffings of Tin in its prefent improved ſtate, has been very lately invented; for by Mr. Carew's account, no longer back than one hundred and eighty years, in queen Elizabeth's reign, the manner of dreffing was exceeding flovenly; and I am very fure, notwithſtanding our prefent advance, we are yet at fome diſtance from perfection in that art. He fays, "As much almoſt dooth it "exceede credite, that the Tynne, for and in fo fmall quantitie "digged up with fo great toyle, and paffing afterwards thorow "the managing of fo many hands, e're it come to fale, ſhould "be any way able to acquite the coſt; for being once brought "above-ground in the ſtone, it is firſt broken in pieces with "hammers; and then carried, either in waynes, or on horfes "backs, to a ſtamping-mill, where three, and in fome places "fixe great logges of timber, bounde at the ends with Iron, "and lifted up and downe by a wheele, driven with the "water, doe break it fmaller.

"The ſtreame, after it hath forfaken the mill, is made to "fall by certainne degrees, one fomewhat diſtant from another; "upon each of which, at every difcent, lyeth a green turfe, "three or four foot fquare, and one foot thicke. On this the "Tynner layeth a certayne portion of the fandie Tynne, and "with his ſhovel foftly toffeth the fame to and fro, that, thro "this ſtirring, the water which runneth over it, may waſh "away the light earth from the Tynne, which of a heavier "fubſtance lyeth faſt on the turfe. Having fo cleanfed one "portion, he fetteth the fame afide, and beginneth with "another, untill his labour take end with his tafke. After it "is thus waſhed they put the remnant into a wooden diſh, "broad, flat, and round, being about two feet over, and "having

"having two handles faſtened at the ſides, by which they ſoftly
" ſhogge the ſame to and fro in the water between their legges,
" as they ſet over it, untill whatſoever of the earthie ſubſtance
" that was left, be flited away. Some of later time, with a
" ſleighter invention, and lighter labour, doe cauſe certayne
" boyes to ſtir it up and down with their feete, which worketh
" the ſame effect: the reſidue, after this often cleanſing, they
" calle Black Tynne. But ſithence I gathered ſticks to the
" buildinge of this poor neſt, Sir Francis Godolphin enter-
" tained a Dutch Mynerall-man, and taking light from his
" experience, but building thereon far more profitable conclu-
" ſions of his owne inventions, hath practiſed a more ſaving
" way in theſe matters, and beſides, made Tynne with good
" profit of that refuſe which Tynners rejected as nothing
" worthe." Thus far Mr. Carew.

Seeing that a dreſſer's judgment is required in the choice of a grate, I begin with a deſcription of that firſt and neceſſary part of a ſtamping mill, which is a thin plate of Iron one-tenth of an inch thick, and twelve inches long by ten wide. The middle of this, from eight inches and an half by ſeven inches, is punched full of holes from the diameter of a ſmall pin, to that of a large reed; for the larger the Tin cryſtals incloſing the Metal are, ſo much the more capacious muſt be the holes, and vice verſâ. This holed plate, commonly named the Grate (I preſume from the cuſtom formerly of diſcharging their ſtamped Tin through grates or iron bars) is nailed on the inſide of the frame, at Y, plate V, near the bottom where the ſtamp heads pound the Ore. The Tin-ſtuff being depoſited on the floor, at C, called the Garden of the Paſs, from thence it ſlides by its own weight, the motion of the ſtamps tackle, and the aſſiſtance of a ſmall rill of water, D, into the box at Y; there by the lifters a, b, c, falling on it, after being raiſed by the axle-tree, d, which is turned round by the water wheel, B, it is pounded or ſtamped ſmall. The lifters are three to each ſtamps, made of aſh timber, ſix by ſeven inches ſquare, and about nine or ten feet long. They are armed at the bottom with large maſſes of Iron called Stamp-Heads, of one hundred and forty pounds weight in each, or more: theſe are lifted up, and let fall, between two upright parallel planks of oak timber, by wooden knobs or teeth, called Caps, fixed in the barrel of the axletree at proper diſtances, and in number proportioned to the circumference of the axis, which goes round by the power of the water wheel. Thoſe caps in their round, take up pieces of of wood called Tongues, about ſix inches projecting from each lifter, which are fixed one in every lifter at a proper place, ſo that each cap from the barrel of the axle comes under the tongues, and lifts them up, one after another, in a uniform rotation. Each lifter with its iron head falling upon the Tin-ſtuff, bruiſes it down ſo ſmall, that it is all diſcharged through the little holes of the grate. The hinder head lifts firſt; that falling, forces the Tin-ſtuff under the ſecond; the ſecond falling, forces it to the third; that falling, forces it on to the ſmall holes in the grate, from whence it is conveyed by the ſame rill of water before mentioned (which likewiſe ſerves to keep the Ore wet, and the ſtamp heads cool) through a ſmall gutter, e, into the pit, F, where it makes its firſt pure ſettlement; for the rough metallick part lies at the head, while the loomy part or ſlime is carried back by the water, to the hinder part, G. Adjoining to this pit is another large reſervoir, H, where the ſlime leavings coming from the firſt pit, are finally depoſited; the remainder which flows over into the river, being reckoned good for nothing.

When the firſt pit, F, is full, they throw it up, carefully ſeparating the good from the bad; or in two parts, the head and the tail, according to the diſcretion of the dreſſer. Then they carry it to the buddle, I, a pit ſeven feet long, two and a half wide, and two feet deep. The dreſſer, or a ſtout boy, ſtanding in the buddle at I, ſpreads the pulverized Ore upon an inclined plane at K, called the head or Jagging board of the buddle, by a ſhovel full at a time, in ſmall ridges parallel to the run of the water, which enters the buddle at L, and falling equally over the croſs bar M, waſhes the lighter parts from the ridges, which are moved to the right and left with a ſhovel till the water permeating every part ſeparates the better from the worſe; the dreſſer in the mean time lightly ſcraping his naked foot acroſs the Tin in the body of the buddle, which raiſes the light waſte, in order to its being carried back by the water whilſt the Tin remains clean in the head or fore part of the buddle. When the buddle is filled in this manner, if the Tin is of a moderate value it is ſorted into three diviſions; that next the jagging board, K, at g, is the pureſt, and called the head or crop, which is ſaved by itſelf; the middle, at h, is next in degree, being named the middle head, but more commonly the Creaſe; and that, at i, being moſt impure, is by ſome called the Hind-Creaſe, which is thrown behind the buddle for leavings, and thence called by ſome the Tails. If need be, the

 head

head of the buddle is buddled over again, and ſo is the creaſe, till it is brought to equal purity with the fore part or head. Theſe buddlings are repeated, till the quantity deſired, to a certain ſtandard of purity, is brought about, as they term it, or freed from its waſte, which is thrown aſide with the tails, and hind-creaſes, for leavings.

It is then carried to a large vat called a Keeve, about one-third filled with water, where the dreſſer ſtirs round the water with a ſhovel, while another puts in the Tin by a ſhovel full at a time, letting it fall down into the water by little and little at the ſide of the keeve, wherein it is continually tozed (toſſed) or ſtirred by the dreſſer with his ſhovel, till the keeve is almoſt filled. By this method the ſmall waſte that remains among the Tin ſwims about in the water. When the toſſing is at an end, a boy or two with mallets employ themſelves for a quarter of an hour beating the ſides of the keeve, near the top (which they call packing) till the whole is ſettled hard, according to the different gravities of its component parts; when the water is poured off from the ſurface of the Tin, and the light waſte upon it is ſkimmed off and laid by itſelf, to be buddled over again by the name of the Skimpings. The Tin is then ſifted through a copper bottom ſieve, into another keeve of water, by which the gravelly waſte, whoſe ponderoſity ſunk it equally with the Tin Ore in packing, is ſeparated from the clean Tin; the Tin that runs through the copper or braſs bottom ſieve, if it does not require to be buddled again, may be made clean by repeatedly toſſing and packing it as before. If it is neceſſary to buddle the Tin over again, after it is ſifted (which is the beſt method for cleanſing moſt ſorts of Tin, for there may lie a rough waſte, that will not come off by toſſing and packing) then buddle it over again, and ſave it in three parts, viz. the crop, the creaſe, and the tail. The crop is to be cleanſed by toſſing, &c. and the creaſe muſt be buddled again, out of which muſt be ſaved as much as will cleanſe by toſſing and packing.

The remainder muſt be cleanſed by an operation called Dilleuing, from Dilleugh, to let go, let fly, ſend away. A dilleugher is a large fine hair ſieve, which the dreſſer holds in a keeve one-third full of water, while an aſſiſtant throws a ſhovel full or two at a time into the dilleugher, which the dreſſer ſhakes to and fro, and, by his dexterity, turns round the water in the dilleugher, till all the Tin that is in it is in motion. He then dips one ſide of the dilleugher under water and raiſes it again,

again, letting the water run over the other ſide, either ſlow or faſt according to his judgment of the nature of the Tin and waſte : the latter will run or fly over, and is called dilleughing ſmalls or pit-works, which muſt be laid aſide, to mix with the ſkimpings, to make the ſamples of a low value, called the rough (or row) Tin. But there is another operation upon this rough Tin to gain as much out of it as poſſible, to mix with the crop, which manœuvre they term "drawing the row Tin in the "buddle," viz. by putting the quantity of a ſmall tub full in the bottom of the buddle, on one ſide forth againſt its breaſt; then with a pretty ſtrong rill of water, moſtly turned the other ſide of the buddle, they draw it with a ſhovel by little and little from one ſide to the other, where the water runs. By the force of the rill, the rougheſt and pooreſt of the row is carried back, while the beſt ſtands forth. This muſt be repeated, till it is cleanſed from the rough gravelly parts, which may be known by vanning of it on a ſhovel: which done, they dilleugh it again, till it is fit to mix with the crop Tin.

The rough that is carried back with the ſtream, by drawing it over again, may be rendered merchantable at a lower rate than the crop; and the rough of this rough, is thrown aſide to make leavings. The pit-works and ſkimpings muſt be ſeparately buddled, toſſed, and packed again, till they are quite clean, and the reſidue put by for leavings. Thus every part is kept ſeparate to make it clean; firſt the head, next the creaſe, then the ſkimpings and pit-works, when all are mixed together for the ſmelting-houſe, there to be bartered for white Tin, excepting a ſmall proportion of row for an inferior ſample, which if mixed with the crop would ſpoil the whole.

A perſon that is ignorant of cleanſing Tin Ore, may ſafely undertake to pronounce, whether a batch or parcel of black Tin is well purified or not, by plunging his wet hand into it; for if there is any waſte in the Tin it will ſtick to his hand; otherwiſe his hand may be drawn without any thing adhering to it, except ſome few evident Tin grains in the lines of his palm: conſequently, if a waſte is thus viſible in ſo few points of contact, then certainly muſt the waſte be very great and prejudicial in the whole batch.

From the deſcription of dreſſing clean work, we muſt proceed, in courſe, to give an account of dreſſing Tin-ſtuff, that is corrupted with Copper, Lead, Mundick, Black-Jack, and other

other Semi-Metals; for fometimes we meet with all thefe forts of Minerals intimately blended in one and the fame ftone of Tin Ore; which being fpecifically heavier than the Tin, whatever Tin-ftuff is incorporated with thefe muft be burnt to evaporate the fulphur, arfenick, &c. after it is firft ftamped, dreffed, and cleanfed from its earthy fordes, in the manner before defcribed, in order to make it fit for calcination in the furnace, called a burning-houfe.

A burning-houfe much refembles a fmelting-furnace, but not in every particular. The furnace is built without doors, at one end of the houfe, where the chimney is raifed to carry off the fmoke and fublimate of the calcined Minerals. The houfe ferves no other purpofe than that of a covering for the man who rakes the calcining Ores, and the prefervation of fome few tools that would be unfafe out of doors.

The foundation of the furnace is built of hewn moorftone about four feet and a half high, on which the bed or bottom of the furnace is laid. Under the bottom, a little towards the houfe where the man ftands to rake the Tin, is left a hollow place for holding the Tin after it is burnt, which they call the Oven, that will contain about fixteen or twenty Winchefter bufhels, with an opening on that fide next the ftamps plot, in fhape and fize much like a fmall chamber chimney, in order to come at and take out the calcined Tin, which is let down through an orifice in the bottom of the furnace adjoining to the houfe. Except at this orifice, the oven is arched over to lay part of the furnace bottom upon. The top, bottom, and hewns (fides) of the calciner were formerly made of moorftone wrought very fine; but brick is now moftly ufed, it being more durable for fire work than ftone. The length of the calciner is generally about nine feet, and the width five in the belly or middle, gradually decreafing towards the chimney or houfe to fixteen inches, and towards the grate or fire place to three feet, which is at the further end directly oppofite to the houfe and chimney. The hewns, or fides, are about ten inches high; upon which is turned a flat arch or covering, which includes the fire place alfo. This grate or fire place is about ten inches wide, and three feet long; at the fide of which, between it and the furnace, is a brick thick partition or bridge three inches high, to prevent the Tin from mixing with the coal. Over this bridge the fire conftantly reverberates upon the matter in calcination, while the fmoke and fulphur afcend the chimney at the houfe-end

end oppofite the fire place. Upon the top of the arch or back of the calciner, is made a fquare hollow place called a Vate or Dry, fufficient to contain a ferving or hand barrow full of Tin, which acquires heat enough to dry it ready for calcination in the furnace below, where it is conveyed through a fmall hole in the bottom of the vate.

A calciner of thefe dimenfions, will confume three Winchefter bufhels of coal to every ferving, if the Tin is greatly corrupted with a ftubborn brood, but moft commonly half the quantity, or lefs, will do ; alfo fome forts of Tin, that are very fulphureous, will yield a flame for feveral hours, and greatly help their own ignition to the faving of fuel in the operation. As for the time of making a complete calcination of a ferving or laying of Tin, it cannot be limited till a trial is made ; for if it is not very foul, it may be burnt in fix hours, and fo on the contrary from that to twenty-four hours, according as it is more or lefs corrupted ; efpecially if there be Copper in it, when it will require a longer time to weaken and deaden the Copper as they pretend, otherwife it will not cleanfe fo well in the future dreffing ; that is to fay, the ignition muft be ftrong, uniform, and conftant, to render the Copper a light wafte to wafh off from the Tin, which by the ftrongeft calcination ufed here, lofes very little of its firft ponderofity.

When the fire is up, and the firft ferving of Tin in the vate is dry, the dreffer lets it down into the furnace through the hole at bottom, where he levels it with his rake through an opening twelve inches fquare, made under the chimney in the houfe. After it is all down, he ftops the hole in the vate with clay, and carries another ferving into it in readinefs for the next layer. The Tin in the calciner muft reft for fome time before it is turned, that it may be quite hot ; otherwife if it be ftirred before ignition it will effervefce and fly up the chimney ; but when it is ignited, and ready for turning, the dreffer rakes it backwards and forwards alternately, moving that which is furtheft from the fire near to it, and that which is clofe by the grate further off. This muft be repeated over again, at due intervals of perhaps every hour, or more frequently if the nature of the Tin requires it. But in either cafe, a ftrong heat fhould be kept up, and the fire not let to flacken, till the Tin is fully calcined ; which may be known by the dead weight of the Tin againft the rake, by its having exchanged its fiery red hot appearance for a black one, and its yielding little or no arfenical fmoke upon ftirring.

The Tin after it has been fufficiently burnt is let down into the oven before mentioned, and from thence is drawn out and fifted in a keeve, through the brafs or copper bottom fieve; whence it is removed to the buddle, and undergoes all the feveral lotions of buddling, toffing, packing, &c. till it is quite clean for fmelting.

Let us now advert to the dreffing of leavings of Tin. Leavings confift of flime and tails; that is, of Tin mud and Tin gravel, which a Lappier, or dreffer upon tribute, will commonly undertake to bring about for the mafter Tinner, for one-third part of the produce to pay his charges; or, in other words, the former will account to the latter, for two-thirds of the produce in white Tin, free and clear of all trouble and expence. The tails I have fhewn before are in abfolute bulk, produced from the hinder or tail part of the buddles; from whence they derive their name of tails. The flime being compounded of the fmall and lighter parts of the Ore intimately mixed with a greater quantity of earth and ftones, bruifed to duft by the mill, is floated on to the flime pit H, which is emptied, as occafion requires, on one fide, into another flime pit called a Hutch, till it accumulates to a great heap, where the water leaks away and leaves it dry, expofed to the fun and air, which do not a little contribute to its better working when it comes to be dreffed; for this we find every day by experience, that the longer the flime is left before it is dreffed, the more profit it yields, and the purer the Tin: from whence fome have concluded, that Tin in the ftate of fludge or flime, by length of time, muft grow and increafe. It muft, however, be confeffed, that the fun and air act as menftrua upon the flime, by confuming or rather diffolving the Poder, that is, the Mundick, particles of Copper, and other trafh, not fo denfe and compact as the Tin, which comes out the cleaner and with greater eafe by fuch infolation and expofure. Therefore, when the water is fufficiently foaked out of the flime hutch, it is removed further off to a large plot of ground near the veffels deftined for its future lavations, where it is fpread and expofed to the weather that it may moulder and decay the fafter. Then it is digged and broken to pieces with a bidax, or hedging tool, when it is trunked and framed, thus:

A trunk O, is a pit lined with boards ten feet long, three wide, and nine inches deep. At the higher end is a circular pit Q called the Strêk or Strep, large enough to contain four hand

hand barrows full of ſlime, where it mixes with a little rill of water that floats it down into the ſemi-circular pit P called the Head or Pednan, wherein a boy treloobs or ſtirs the ſlimy water round about with a ſmall ſhovel, that the water may waſh away both the filth and Tin over a croſs board ten inches deep at the lower part of the pednan: the board is ſomewhat lower in the middle than at each end, for admitting the watery mixture with more eaſe into the body of the trunk O, R, R: that which reſts in the fore part of the trunk at O o, is carried off to be framed, and the ſettlement at R, R, is moved forwards to P, to be trunked over again before it is fit for the frame: the rough grains lie at the bottom of the ſtrêk, whence it is removed for ſtamping, and the moſt light and ſmall ſlime paſſes the bottom or lower end of the trunk into a pit, where it ſettles and acquires the name of Loobs.

The frame or rack T W, conſiſts of two inclined planes of timber; the body W, the head T. The frame is an oblong ſquare eight feet by five, with ſides four inches high, all joined cloſely, that nothing may eſcape but at the extremity or lower end. At the middle of the two ends are fixed two round projecting irons called Melliers, by which the frame hangs and turns as it were on an axis, upon two upright pieces of timber one at each end, whereby the frame may be ſwung up and down, perpendicular to the horizon. The head T, is two boards wide, and in length parallel to the breadth of the frame. To the bottom of this is joined a water head, or board, ſeven inches high; to which is hung, by hinges, a ſlight piece of board ſix inches wide, and the length of the head, called the Lap, or Lippet, whoſe uſe is to convey the water and Tin equally down upon the frame. Underneath the fore part of the frame, is fixed a little tray or cheſt three feet long, called the Kôfer, and another at its lower end called the Hind-Kôfer.

The water falling in a gentle manner from S upon the head T, waſhes the Ore, which there offers itſelf (as at the buddle) in little ridges, downwards over the lippet, upon the body of the frame W. On this frame the water is ſpread ſo thin, and runs ſo ſlowly, (the plane being very little inclined) that by moving the ſlimy Tin to and fro with a light hand, and expoſing it cautiouſly to the water by a ſmall ſemi-circular toothleſs rake, all the ſordes are waſhed away, and the Tin though ever ſo ſmall, remains on the frame near the head. When the Tin is found ſufficiently clean, the body of the frame being hung on melliers,

melliers, as I have ſaid before (by ſlipping the ſtake underneath, which ſupports it) is turned eaſily from horizontal to perpendicular; and the Tin which remains on the frame runs off, by the aſſiſtance of a little ſprinkling, in two degrees of purity, into the fore and hind kôſers. The frame is then righted into its horizontal poſitions, and the proceſs repeated till the kôfers are full. The ſmaller ſlime, which runs off the lower end of the frame, is yet preſerved in a pit by the name of Catchers, and makes a part of the loobs or leavings of leavings, to be worked over again at a future time. The contents of the fore kôfer is then ſifted through a fine hair ſieve or copper bottom, into a keeve with water in it, to ſeparate the gravel, chips, or any other accidental mixture from it. Then it is buddled and ſaved in different portions, like crop Tin; as well undergoing the ſeveral operations of toſſing, packing, ſkimping, dillhuing, &c. After all, if the Tin is very ſmall, it is carried to the frame again, and reframed or cazed, as they term it; which is performed, by ſtoping the lower end of the frame with mud and turf, that the water may be almoſt ſtill, and the Tin more eaſily ſettle upon the frame, and deſcend the more ſurely into the kôfer: the fore kôfer is then emptied the ſecond time, the Tin carried to the keeve again, there toſſed, packed, ſkimmed, &c. and thus the ſlimes are finiſhed, and brought to as great a degree of purity, as the ſize of the Tin will permit, which being exceeding ſmall, will neceſſarily have ſomewhat more of waſte, than what is larger and heavier.

The great pile of tails behind the buddles, are commonly waſhed down into the trunk below, by a pretty ſtrong current of water, which may be rendered more or leſs forcible by an alteration of its fall, to divide the rough from the ſmall, by treloobing them in the ſemi-circular kôfer of the trunk with a ſhovel. The ſmall that flaſhes over into the trunk, is deſigned for framing, and ſo divided into two parts, the fore, and the hind kôfer. The latter muſt be toſſed and framed again; but if the fore kôfer is pretty good, it may be toſſed and packed, the ſkimpings of which muſt be cazed in the buddle, that is, one perſon buddles it as uſual, but with a very ſmall ſlow ſtream of water, while another with a few quils fixed on the end of a pole, lightly ſweeps the buddle acroſs from ſide to ſide, beginning at the bottom, and ſo proceeding forward every ſtroke, till he comes to the breaſt of the buddle, when he returns in like manner progreſſively to the end or tail. By this method it is made fit for cleanſing in the keeve, &c. and the hind part, that

that is not fit for toſſing, &c. muſt be framed again, and proceeded with in the former manner.

Mean time, all tails that are taken from the bottom of the trunk head or pednan, together with the roughs (or rows) that come from the ſlime, or from the toſſings of the hind and fore kôfers, that are not of a proper ſize, muſt be ſtamped over again, and dreſſed in the manner before mentioned for bringing about the crop Tin or bal work. But in the ſtamping them, care muſt be taken to ſuit them with a proper grate and ſmall weight of tackle, or worn old ſtamp-heads; otherwiſe they may be ſtamped under ſize, and choak the grate, which they call being dumbed; to prevent which, they mix with them a ſmall quantity of Goſſan or poor Tin-ſtuff, to cut and jagg them up, elſe the ſtamp-heads would mudify them too much to paſs the grate holes as freely as they ought: nay I have known common Quartz uſed for this purpoſe, entirely deſtitute of Tin. If there be a corrupt brood in the leavings Tin, ſo as to damage its value two parts in twenty, it muſt be burned in the manner before directed, but with a leſs violent fire, and then dreſſed again from its calcined impurities: the calcination of leavings Tin ſhould, however, be always avoided if poſſible, becauſe it is ſo fine, like floran Tin, that it will, by its ſized levity, be elevated and carried off, together with the arſenick and ſulphur.

The modes of dreſſing Tin and its leavings, are too various to lay before the reader, without danger of prolixity: all of them depend upon the difference of the kinds of Tin in the ſtone, and muſt be dealt with, agreeable to the judgment of ſeveral manufacturers. So much depends upon the ſkill of a dreſſer, that one may ſave one-twelfth part of a batch of Tin, which another for want of equal knowledge may caſt away in waſte, or perhaps take up ſo much waſte with it, as to depreciate the value of the whole by two parts in twenty. Neverthelefs, all dreſſers ſave the hinder ſtuff from the frame end, as it waſhes off in a pit by the name of Catchers, which is expreſſive enough; and likewiſe the mud at the trunk ends, by the other name of Loobs, both of which are denominated the Loobs, after leavings, or leavings of leavings. Theſe are wrought over in the ſame manner as the former, moſtly upon tribute, by an aged workman and a few little boys in the ſummer months, when they can ſtand out in good weather, and do a long day's eaſy labour. The tribute paid by the undertaker is one-third

 of

of the produce in white Tin; the other two-thirds he has for himſelf to pay his coſt and charges.

Proceeding upon this ſingle principle, that the force of water, properly applied and introduced among the particles of Tin Ore and the ſordes mixed with it, will diſperſe the latter and leave the former at reſt for them to collect and treaſure up, they vary their operations inconceivably, conducting them with great ingenuity, leſſening, encreaſing, diffuſing, or contracting their water, the great inſtrument of purity, as the ſize, weight, and combinations of the Metal and its feeders require; and that with great eaſe, cheapneſs, and regularity, throughout the ſeveral proceſſes.

Hence, this buſineſs of dreſſing is a particular trade, entirely different from that of the labouring Miner; and is beſt learned under a maſter workman, who makes it his ſole occupation to follow the ſtamping mill and the works belonging thereto. This maſter workman hires boys from ſeven years old to eighteen, gives the former about three ſhillings a month, and raiſes their wages as they advance in years and workmanſhip, till they have man's wages, viz. at the leaſt twenty-four ſhillings, at the higheſt thirty ſhillings ℘ month. This is of double benefit to the poor parents; and the boys being taken in ſo young, become healthy and hardy by uſing themſelves to cold, and to work with naked wet feet all day; and they learn early to contribute to their own maintenance. Each ſtamping mill which has conſtant work and water, will employ one man and five boys; and one hundred ſacks are carried, ſtamped, and dreſſed, in the ſpace of a few days, at the average rate of about fourpence ℘ ſack, or one guinea and a half ℘ hundred.

We ſhall here obſerve, that even burnt leavings of Tin are often conſiderably valuable, eſpecially if they are cupreous; and even the pooreſt of theſe leavings bring ten or twenty ſhillings ℘ ton; which is better than to throw them away, as was the caſe no further back than forty years. All burnt leavings taken from Tin-ſtuff, till the year 1735, were eſteemed good for nothing. But in that year there were ſeveral ſmall parcels lying on ſundry ſtamps plots in this pariſh, which induced Mr. Morgan Bevan, an old experienced aſſayer, to try whether he could reduce them into Metal. For the firſt time he aſſayed a ſample of three tons; and, to his own great ſurpriſe, as well as that of others, he found that he could give ſeven pounds four ſhillings and

and ſixpence ℘ ton for them, which he actually did, and preſently after bought ſeveral parcels more of Meſſrs. Carter, Reynolds, Penroſe, Corniſh, &c. the principal Tin dreſſers of thoſe days. From that time all burnt leavings were taken much care of, provided they were ſufficiently impregnated with Copper; for ſome of them are merely Mundick, with little or no Copper in them. When the Braſs-wire Company carried on the great Tin Mine of Chacewater, before this diſcovery they caſt away ſome hundred tons of burnt leavings, to their great prejudice; but ſince that time there have been large quantities ſold from the ſame Mine.

The very water in which burnt Tin is waſhed, may be converted to a uſeful and profitable account, either by evaporation to a pellicle for cryſtallization of Copper, commonly called Blue or Roman Vitriol; or for the precipitation of Copper by the medium of Iron, laid in veſſels filled with this vitriolick water. The precipitation of Copper by Iron, is too generally underſtood to make an explanation neceſſary here; but we have obſerved among our Copper precipitate, where it has been effected by a very ſtrong ſolution with the cleaneſt Iron, ſeveral pieces of malleable Copper, ſome of them retaining the form of the Iron, like incruſtations fallen off from it. Hence it ſeems as if there was a degree of attraction between the Iron and the particles of Copper, floating in the water; as well as the more obvious attraction between the acid and the Iron. Muſt not the particles of Copper thus attracted, cohere by their own magnetiſm, or the attraction of coheſion?

It may not be improper to add how far this quality has already tended or may tend to the advantage of the publick. Perhaps the hiſtory of its riſe and progreſs in this country, and in Ireland, may ſerve to illuſtrate that matter. About ſixty years ago, this phenomenon was firſt obſerved by Mr. Coſter in Chacewater Mine near this town; for after he had drawn out the water, which had been in the Mine for ſeveral years, he found the poll of a pick-axe wholly encruſted with a caſe of malleable Copper between two and three pounds weight. This it was juſtly ſuppoſed was obſerved by the workmen, ſome of whom afterwards ſettled at Cranbaun Mine in the county of Wicklow in Ireland. The water of Cranbaun having this vitriolick acid in a very high degree, Capt. Thomas Butler, who was one of Redruth, and manager of that Mine, perſuaded the proprietors to adopt the ſcheme of precipitating Copper, of which

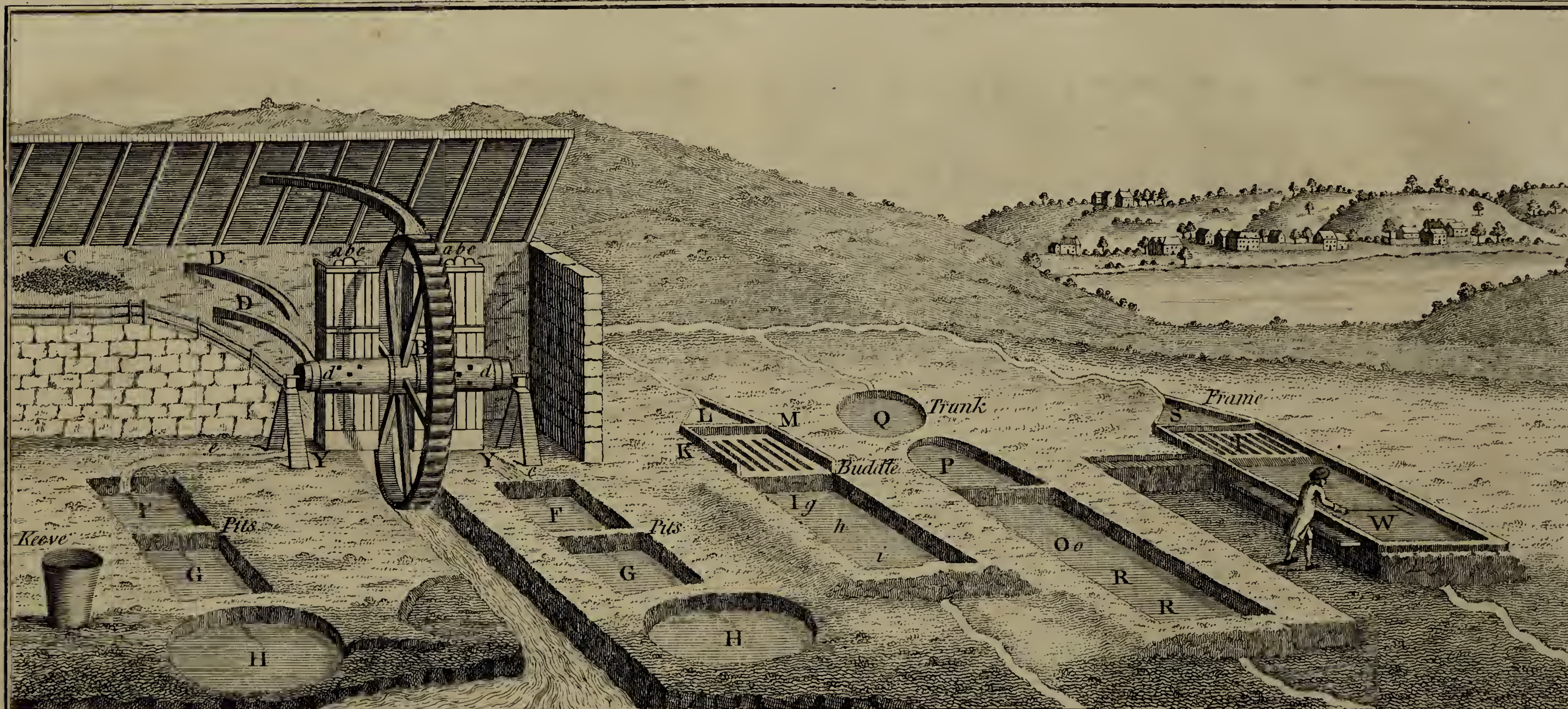
which they have made for many years paſt and now continue to make very conſiderable profit. They dig pits at proper diſtances in the Adit, (or ſo near as to admit the water) in which pit they place wooden rails, ſomewhat like a bottle rack, ſo as to ſuſpend the Iron thereon. They put in many tons at a time; and, in about ſix weeks, the Iron is totally diſſolved. The precipitated Copper is then taken out, fit for ſale; the greateſt part in the form of our Goſſan pounded, with ſeveral grains of pure Copper interſperſed.

An attempt of this kind was ſome years paſt made in Huel-Crafty, but without ſucceſs; for the water being in one part of the Mine only, and in no greater quantity than would run through a quill, was too much diluted by other water mixing with it in the hutch where the Iron was placed; beſides, the Iron itſelf was very ruſty which will always obſtruct the ſucceſs, unleſs the water is in the higheſt degree impregnated with the acid. A ſmall and ready experiment proves this; for take a bright piece of Iron, ſuch as a key, or poliſhed knife, and immerſe it in the water for half a minute, and it will be ſtained of a Copper colour. Many Mines in this county have ſome rills of this water, ſo as to do conſiderable miſchief, without having as yet (perhaps for want of proper attention) applied it to this uſe.

But though we may date the firſt hints relating to this matter in England and Ireland from the foregoing diſcovery in Chacewater, it is no new thing in other countries. Brown mentions it in his travels into Hungary, as a profitable appendage to the Mining of that country. Dr. Rutty, in his Natural Hiſtory of Dublin, ſays, "Our water at Cranbaun in the county of "Wicklow, may well vie with thoſe of Herengrund and Ciment "in Hungary. Of ours I received the following account in the "year 1765 from a perſon converſant in theſe matters."

"It is ſaid to tranſmute Iron into Copper; but the fact is, "that it precipitates its contained Copper upon Iron bars im-"merſed. It continues in its full ſtrength; and, in ſeven years "laſt paſt, yielded to its proprietors a ſum no leſs than ſeven-"teen thouſand two hundred and fifty-nine pounds eighteen "ſhillings and ninepence halfpenny, and all this without any "expence of fuel and men. The precipitate thus formed being "fluxed, yields above half of pure Copper: for an ounce gave "twelve pennyweights and eighteen grains in one experiment, "and thirteen pennyweights twelve grains in another."

Plate V.



To the Right Hon.ble Humphry Morice M.P.
Lord Warden of the Stannaries and Steward of the Dutchy of Cornwall.
This Plate Engraved at his Expence is most gratefully Inscribed by
W.m Pryce.

C H A P. II.

Of Dreffing Copper and Lead Ores, and Sampling Copper Ores for Sale.

WHOEVER confiders the diffimilarity of Copper Lodes, in my chapter "on the different kinds of Lodes in "refpect of the earth and ftones they contain," will foon perceive, that there can be no uniform method for dreffing their Ores: the hard and poor Ores require much bruifing, and many lotions, before they can be feparated clean, and made fit for fale, fuch as the hard Peach, Quartz, Killas, Mundick, and Black-Jack; but the more tender Peach, Pryan, Cryftal, Killas, Mundick, and Flookan Lodes, admit of lefs handling, lefs water, and of courfe are attended with lefs expence in the dreffing, provided they are well given for Ore; for it is one general maxim, that a judicious application of water, the principal feparator of them from their fordes, conftitutes the firft article of fkill in dreffing Copper Ores.

The manner of dreffing and cleanfing Copper Ore, is partly like that of Tin; but as good Copper is commonly dug and raifed in large maffes, as little mixed with any thing elfe as poffible, a great part of it is folid Ore that needs no wafhing. When it comes to grafs they make a fortment of the larger ftones from the fmaller, and fpâl or break them to a lefs fize, throwing afide the poorer part, which is afterwards to be ftrêked and wafhed. But when Ore rifes plentifully, and with little wafte, it may perhaps be a lofs and detriment to wafh it; and, therefore, if it comes moderately dry, a perfon near the Shaft where it rifes, fifts it in a Griddle, or iron wire fieve, of one inch meafh or lefs. The part that runs through the griddle, if not clean enough for fale, is wafhed; and it is feldom that griddled or fmall Ore is fo pure and clean as not to require wafhing. The poor and fmaller Ore is generally carried to the ftrêke or ftrakes, fometimes after being griddled, but oftner before, and as it comes out of the Mine.

The ftrêke or ftrakes is made of two deal boards laid flat for a bottom fourteen inches in the ground, on an inclined plane, with two fides formed of one deal board each, refembling a

 narrow

narrow ſhallow cheſt without a cover. In this runs a pretty quick ſtream of water. One perſon throws the foul Ore into the ſtrêke, while another moves and toſſes it with a ſhovel in the ſtream, by which means the ſlimy earthy parts are carried by the water into a ſlime pit juſt below; and the ſtony coarſe poorer part ſettles in great meaſure on the tail or lower end of the boards, which at times is divided, and caſt aſide to be ſtamped, as it contains ſome Ore. The better Ore by its gravity, and a peculiar motion of the ſhovel in ſtirring it, reſts at the head of the ſtrêke. But if there be much pure Mundick in it, this alſo ſettles moſtly near to the head of the ſtream, becauſe it is more ponderous than moſt ſorts of Copper Ore; and it is ſeparated and laid by itſelf. Moreover, the largeſt ſtones, either of Ore or waſte, riſe uppermoſt by the motion of the ſhovel; theſe the dreſſer throws on one ſide of the ſtrêke, where women and children ſit to pick out the good ſtones of Ore, and are from thence called Pickers. The remainder is laid by to be Bucked, or broke ſmaller with flat iron hammers made for that purpoſe, if the Ore be worth this trouble; otherwiſe it is carried to be ſtamped.

The picked Ore, which is rich and ſolid, is put to a number of girls called Cobbers, who break it on large ſtones with flat polled hammers to the ſize of a cheſnut and leſs, and it is then called Cobbed Ore, being the ſame as Knocking or Bing Ore in the Lead Mines. This requires no water, nor further dreſſing, being fit to mix for ſale. The ſtony Ore that is left by the pickers, which is called by ſome Dredge Ore, from its being poor and ſprinkled as it were in the ſtone, and alſo the little refuſe which is ſeparated by the cobbers, are carried to the bucking-mill, which is ſomething like a wooden coal ſcuttle placed on a low hedge with a hard ſtone at its lower narrow end, whereon a ſtrong wench with her flat hammer or bucking iron breaks thoſe ſtones, to the ſize of ſmall beans or peaſe.

From thence it is carried to the kieve or vat, where it is further cleanſed by an operation called Jigging; which is by far the beſt method, not only for thoſe Ores which have undergone a previous lavation, but alſo for all tender rich Ores, as they are immediately dug out of the Mine.

Preparatory to jigging, they fill the kieve half full of water, on the ſurface of which the jigger holds a coarſe wire ſieve of two holes to the inch, while another perſon throws the unclean Ore

Ore into the ſieve, which the jigger dips into the water and ſhakes twice or thrice until the ſmaller part falls through to the bottom of the kieve. What remains in the ſieve, he reſerves by itſelf, till there is a quantity. This coarſer ſize made by the ſieve, is jigged pure and clean, if it be well given for Ore; or elſe it is picked, and the refuſe bucked over again, purſuant to its richneſs or poverty, and the dreſſers direction and judgment. When the kieve is almoſt full, they pour off the water, and take out the ſmall Ore, which perhaps they ſort again after the ſame manner in ſieves with leſſer holes. Being thus divided, they dreſs each ſort apart, in kieves half full of water with proper ſieves, whoſe holes are ſmall enough to keep the Ore from running through.

The jigging ſieve made of braſs wire four or five holes to each ſquare inch, and ſometimes for ſmall Ores ſeven or eight holes, is held by the jigger in the kieve, while a girl throws two or three ſhovels full of the Ore into it. The jigger dips and ſhakes it a few times in the water, by a peculiar indeſcriptive motion and turning of the hand, which makes the light waſte, ſuch as Quartz and Killas-gravel, &c. riſe uppermoſt in the ſieve, the Ore lying under it, and the Mundick (if in any quantity) under the Ore, each according to its ſpecifick gravity. Now to ſeparate theſe, the jigger takes a ſmall ſemi-circular piece of wood called a Limp, being the ſhape and ſize of half the head of a quarter hundred powder barrel, with which he ſcums or rakes off the light refuſe or gravelly part, and throws it by, perhaps to be jigged over again. In like manner he ſcums off the good Ore, and lays it aſide for ſale. Laſtly he reſerves the remaining Mundick, until it comes to ſome quantity, in order to jigg it over again; becauſe the firſt operation may not be ſufficient entirely to take out all the Ore, either from that or the light waſte that lay uppermoſt.

This refuſe part of the Ore is commonly ſo light, being as I have juſt ſaid, a Quartz and Killas-gravel, that it may ſometimes be very properly put to the ſtrêke, and waſhed in a pretty quick ſtream of water, which will carry the waſte to the tail or hinder part of the ſtrêke, ſo as to be divided from the good Ore, which lies at the head. But the ſlimy fine Ore, which falls through the fine ſieves to the bottom of the kieve, is often cleanſed by the tye, which is the ſame as the ſtrêke, but with an exceeding ſlow and ſmall ſtream of water, or, which is much

like

like it, by buddling or framing, the ſame as Tin Ore ; alſo by jigging it in a very fine cloſe ſieve like a dilluer.

All this is varied and modified according to the diſcernment of the dreſſer : and though Ore cannot be perfectly dreſſed by water ſo as to be entirely clean, yet all Ore, except Tin-ſtuff, is beſt cleanſed by jigging, though it is the floweſt way, and of conſequence the moſt coſtly ; alſo the ſlimy earthy part is apt to lie among the laſt or ſmalleſt Ore, more than in the other methods of dreſſing, and thereby depreciate its value : therefore I ſuppoſe the fine ſlimy part of it may be packed in kieves like black Tin ; but the dreſſer's guide in this caſe, ſhould be the tenderneſs and value of the Ore. Here is not, however, that waſte of Ore, that is made by the ſtrakes, which is the reaſon why the method of jigging ought to have the preference.

As the foregoing is the moſt general rule for dreſſing of Copper Ore that I can form, it would render my diſſertation upon the ſubject too prolix, minutely to deſcribe the various methods of cleanſing different ſorts of Ore : I ſhall, therefore, content myſelf with juſt hinting the ſeveral diſtinct operations each ſort ſeparately requires, and leave the regulation of them to thoſe who are employed in the buſineſs.

Common yellow Ore ſhould be ſeparated at the Shaft ſide, the rough from the ſmall, either by griddle or ſtrêke. The ſolid Ore ſhould be further diſunited from the ſtony part, by ſpaling with ſledges, or cobbing with hammers to a proper ſize.

Dredge Ore, which may be left from the above, or which may riſe ſo poor and diſſeminate in the ſtone from the Mine, as to deſerve that name, in the firſt place, ſhould be ſpaled, cobbed, and then bucked to a proper ſize to run through a ſieve two holes to the inch, preparatory to its being jigged in a four or five hole ſieve. The remainder ſhould be waſhed, and then put on a table of looſe deal boards, that the pickers may chuſe the good from the bad, that the good may be handled as the firſt. The ſmall, which runs through the four or five hole jigger, ſhould be tyed in a fine ſmall ſtream of water ; and thus by repetition be made fit for ſale.

If Copper and Tin Ore are mixed together, which is often the caſe, the latter being moſtly the heavieſt body, may be wholly ſaved in the fore part of the tye, by repeated eſſays.

But

But if each Ore is of equal gravity, (and I apprehend ſome poor Tin Ore, which they call dry for Metal, may be leſs ponderous than Copper Ore) if the tye will not ſeparate them, they ſhould be firſt cleanſed from every other impurity, and then moderately calcined in a burning-houſe. The Copper Ore being thus rendered light, will eaſily ſeparate from the Tin, and both will be made ſaleable by buddle, kieve, dilluer, &c. I am not certain whether all this may be too expenſive or not, eſpecially when I recollect that ſome buyers of Copper Ore may prefer it with ſome Tin for ſmelting to pot and bell-metal.

Copper Ore that is charged with Mundick, may be diſunited at the ſtrêke or by jigging, provided the Mundick is hard and ſolid ; but if it is ſmall and fine like ſand, it muſt be ſeparated by the tye, buddle, kieve, &c.

If the infection is Black-Jack, care muſt be taken in cobbing and picking to divide them, as they are nearly of one weight. Some have adviſed calcination ; but they are alike ponderous after calcination ; and, therefore, water will equally float them away. Mock-Lead is not the worſt brood in Copper Ore, eſpecially for the uſe of the braſs founders, it being a Zinc Ore.

Gray Ores are generally the heavieſt of all, and are commonly infected with Iron. They muſt be dreſſed like the common Ores, by ſorting and ſizing them, &c.

In the dreſſing of light pryany black Copper Ore, very little water is neceſſary ; for the ſmall ſhould be ſifted, and put to pile from the Shaft ſide ; and the remainder muſt be cobbed, bucked, and jigged : but if it is committed to a ſmall ſtream of water, the major and beſt part of it will be carried away and loſt by its ſuperior levity and fineneſs.

The prime Ore being ſeparated and dreſſed by itſelf, the refuſe goes by the names of Halvans and Hennaways ; and is generally dreſſed over again and again by ſtrêke, ſtamps, &c. The halvans of halvans are moſtly dreſſed by an undertaker for ſo much in the pound ſterling of the money they produce, according to the richneſs or poverty of the Ore, and the price ℔ ton it will bring when ultimately dreſſed. No exact eſtimation can be made of the value of a pile of Ore halvans : the method of calculating, is by gueſſing how many tons of Ore it will make for every hundred ſacks of the pile. As for thoſe halvans, whofe contents are lefs than half a ton ℘ hundred facks, it is fcarce worth the trouble of returning and dreffing it, except the Ore is rich in quality, and will bring a good price: much alfo depends in this cafe upon conveniencies, care, and expence more or lefs in carriage and water to drefs it.

Halvans ftamped fmall, and then wafhed in a ftrêke with an eafy ftream of water, is termed Stampt Ore. But a finer fort is ftill to be had from the flime pit, which proceeds from the minute particles that glide away with the mud and water; this fort will not bear a brifk ftream, therefore it ftill retains much dirt and mud, whence it is called Slime Ore. The rough part of ftampt Ore fhould be tyed in a ftream of water, and the hinder part of the tye jigged through a fix or feven hole fieve. If it is much adulterated with Tin, Lead, or Mundick, it muft be cleanfed by frequently tying or buddling of it. In order to clear the earthy fordes from the flime or loobs, it may be trunked, and after purified by the buddle, kieve, dilluer, &c. the fame as flime Tin, if it is worth the expence. It muft alfo be noted, that Copper Ore requires a coarfer plate or grate in ftamping, than Tin does, becaufe it is of a lighter nature and more fleaky.

I have heard of a poor fandy Copper Ore fomewhere in Wales, of the appearance of verdigreafe, which is fo light, that the cupreous part of it will not bear even the leaft ftream of water: they drefs it by grinding, dry ftamping, or bucking; then put it into tubs or kieves, and tofs and pack it the fame as I have obferved of Tin: now the real Ore in it being without any fulphur, or much Metal, is fpecifically lighter than the wafte or fand; therefore the Ore fwims uppermoft, and is fkimmed off in the manner of Tin fkimpings. But I fuppofe thofe extreme light Ores are fo very poor, that none would be concerned with them, only in hopes of their improvement.

It is worth notice, that Copper Ore may be too curioufly or too remiffly dreffed, fo that either way the adventurers may incur a lofs; the ground of which is fometimes not fo well confidered as it deferves. If too much time and coft are expended in dreffing the Ore, every one will grant it infers a lofs; but on the other hand, if too much foul Ore is left in it, that will alfo be to the prejudice of the concerned. Every ton of wafte Ore cofts as much to be fmelted as a ton of clean; at leaft, the buyer fubftracts as much for a ton of the one, as the other.

Suppofe

Suppofe the buyer allows three pounds fterling for his charges of fmelting and working a ton of Ore, and confequently the fame fum for each ton of wafte in the Ore, which in reality the fmelting cofts the buyer or refiner; and therefore he muft deduct fo much from the produce of the Ore ℔ ton. This is the cafe in Cornwall; but in other places, more diftant from the furnaces, in Ireland for inftance, the deduction muft amount to more money, in proportion to the duty there on Ore, and alfo an overplus of freight, and if there be any other furplufage of coft, more than in Cornwall, as a longer carriage by land, and the like, all will operate to leffen the value of the Ore: but where fuch incidents are lefs than common, as a very fhort freight, or little charge in land carriage, then inftead of a deduction, there is room to make a further advance of the price.

To illuftrate this cafe, fuppofe one hundred tons of Copper Ore, to be worth ten pounds ℔ ton, the amount of which will be one thoufand pounds; fuppofe alfo it has fo much earth or wafte in it, that it may be reduced to fifty tons, with a moderate charge in dreffing, and with an inconfiderable lofs of the Ore; then each ton will contain nearly the Copper which two tons did before: and whereas the buyer would have taken out fix pounds for the charges of carriage, freight, and fmelting of two tons, he will now deduct but three pounds for thofe charges upon the fame Ore in one ton: fo that inftead of deducting three hundred pounds on the one hundred tons of Ore, he will now deduct but one hundred and fifty pounds on fifty tons, whereby the adventurers will fave fo much of the other one hundred and fifty pounds, by how much the parcel of Ore will coft lefs for dreffing and taking out the wafte; for the fifty tons of Ore will now be worth twenty-three pounds ℔ ton, which will amount to eleven hundred and fifty pounds inftead of one thoufand. Yet if the Ore be light or rich, there may be more of it loft, than the ufelefs wafte carried off may compenfate.

Again, if one hundred tons of wafte were mixed with the one hundred tons of Ore worth ten pounds ℔ ton, then the buyer would make an additional abatement of three hundred pounds more for his charges upon the one hundred tons of wafte; fo that the whole amount of the Ore, would be but feven hundred pounds, inftead of one thoufand pounds; for the Ore would be only worth three pounds ten fhillings ℔ ton; according to which, it is plain, that Ore may be too curioufly or too carelefly dreffed. For Ore rich in nature, may be brought to a great a great rate, and produce a large profit to the adventurers; otherwife it may be fold to a great difadvantage, and without any gain, for want of being well handled: there are, however, feveral poor Ores, fo dry and barren by nature, that they are not capable of being fo well conditioned, as to bring a good price.

The conclufion I would draw from hence, is, that if a ton of wafte can be taken out of the Ore, for lefs than the charge of fmelting a ton (which I call three pounds here) and without any confiderable lofs of Ore, the adventurers fave money by dreffing it thus: but if the charges of taking out a ton of wafte arife to more than three pounds, then they lofe as much as the excefs of coft amounts to, together with the Ore wafhed away; hence, mediocrity fhould always be obferved.

The dreffers of Copper Ore often work for monthly wages, but then they do not always make the difpatch they ought; therefore they more commonly agree with the adventurers at a certain or fixed price for every ton of dreffed Ore; but this makes it the dreffers intereft, to make the greateft number of tons that he can, fo that the adventurers may fuffer a lofs, for want of a true cleanfing the Ore. To prevent this inconvenience, the beft method is to fet the Ore to drefs in proportion to the price it brings ℔ ton; or in other words, to allow the dreffer fo much in the pound fterling, according to the price the Ore will bring; for this makes it his intereft, as well as the adventurers, to make the Ore as merchantable as he poffibly can: however, he fhould be ftinted from throwing away too much Ore in the halvans, or be obliged to ftamp the halvans, and return their contents in Ore.

There can be no ftated rule given for fetting Ores to drefs at a price, becaufe the Ore is incompact, or lefs, as well as poorer in value, in fome Mines, more than in others; but where Ore rifes with little wafte, it may be dreffed at a much cheaper rate, efpecially if it be rich in quality. I have known Copper Ore in feveral Mines, where it might be fifted out at the Shaft fide, without any other trouble, to be dreffed for one penny in the pound fterling; on the other hand, five fhillings may not be a fufficient price for Ore that is hard and barren.

It may be worth enquiry, whether very fulphureous Ores which abound with Mundick, may not be advanced in value by by a previous uſtion. It is evident from the foregoing obſervations, that if Ores be made conſiderably lighter by being burnt and deprived of their ſulphureous heavy waſte, with a ſmall charge and no loſs of Metal, that then it muſt be an advantage to the owners, by putting the charges of ſmelting the evaporated Mundick into their own pockets. Suppoſing this ſhould anſwer the end propoſed, the moſt proper time of burning muſt be after the Ore is dreſſed and fully cleanſed by water; for if it were done before, the Ore would acquire ſo great a levity and tenderneſs that it muſt unavoidably float away, in a great meaſure, with the water, though but a very ſmall ſtream, and be inevitably loſt and conſumed: it would likewiſe be ſo much ſmoked and diſcoloured, that it might deceive the dreſſer in judging when it may be right clean. Nevertheleſs, if a parcel of Ore be dreſſed clean and then burned, a great part of the Mundick muſt evaporate, and the Metal or Ore will remain in the pile; therefore, for every ton of Mundick, that would ſublime from it, the parcel would be worth three pounds more on the entire quantity. For inſtance; if one hundred tons of very pyritous Ore were decreaſed to eighty by this method, the adventurers would ſave ſixty pounds, from the diminution of its weight or loſs of Mundick; as well as gain, by its improved value, as much at leaſt as would pay the charges of burning, which I preſume would be ſmall, for the Ore may be burned in furnaces ſimilar to thoſe commonly uſed for the calcination of limeſtone; or by kindling piles, conſiſting of ſtrata of fuel and of Ore placed alternately upon one another, and by other pieces of uſeleſs timber, which ſhould reach from top to bottom of the piles. Theſe being burnt out, and the Ore ſettling ſteady, the vacancies of the burnt timber would ſerve as flues or chimneys to carry off the vapours, and keep the fire from being extinguiſhed too ſoon, eſpecially if the ſmall Ore was thrown on after the other Ore was well kindled and throughly burning.

Otherwiſe, a ſmall arch or channel of looſe bricks may be placed on the ground, where part of the round Ore may firſt be eaſily kindled by a fire of charcoal or wood; and as the fire increaſes, the place may be fed and ſupplied with more Ore, till the whole pile be ſet on fire; for Ores that are very ſulphureous, are ſo combuſtible, that they ſoon take fire, if well ordered, and will burn a long time, or till they are moſtly deprived of their ſuperfluous ſulphur, when the fire extinguiſhes of itſelf, for want of a Pabulum or feeder. Fig. 11, plate VI, repreſents a quantity of Ore piled up to be burned: 1. two ſides

 or

or faces of the pile: all the ſides of it are covered with ſmall Ore: 2. the upper part of the pile where holes are ſeen, which ſerve as flues both to help burn and evaporate the Mundick and ſulphur: 3. an opening to ſet fire to the pile, and in which the ſulphur may drop pure when melted: 4. a plank to keep off too much wind. Fig. 12, is a ſection of the above pile: 1. the wood to make the fire: 2. ſome charcoal for kindling the fire: 3. a channel formed by a wooden tube or pipe to begin a draught of air: 4. large lumps of Ore: 5. ſmall Ore: 6,7. finer Ore, or duſt of Ore.

When the Ore grows cold, it is fit for ſmelting, but muſt by no means be any more cleanſed in a ſtream of water. By this management it will run much freer in the great furnaces for ſuch a gentle deprivation of its ſtubborn brood of ſulphur and arſenick; and I am pretty clear will alſo yield more Metal, than when it is melted crude in the furnaces, where the ſulphur and arſenick being excited by a violent fire, may elevate or carry off ſome part of the Metal in their paſſage. The worſt inconvenience that ſeems to attend this matter, is, that it requires to be done near the Mine, to prevent the charge of removing the Ore; in which caſe, the ſmoke being blown by the wind, would be offenſive to the workmen, without a due precaution to prevent it. To my aſtoniſhment, neither this method nor any thing ſimilar to it, takes in Cornwall, though it has been uſed with ſucceſs in Germany, it ſeems even before the Ore is waſhed clean; and therefore it may much more reaſonably be thought to turn to account, after the Ore is cleanſed.

Indeed, the adventurers of Bullen-Garden Mine, ſome few years paſt, not only calcined their poor Copper Ore, but ſmelted it likewiſe into a regulus, and that at an expence which was very eaſy to be borne for the improvement of the Ore in its value: but this attempt was of no long duration, the Copper Ore buyers very honeſtly confirming the ſuſpicions of the adventurers, that they did not, neither would they offer at ſo high a ſtandard for Copper Regule as they would for Copper Ore, becauſe an encouragement of this kind, would neceſſarily deprive the trade of ſome part of the labour, which was very profitable to them. That argument, backed by a more powerful one, viz. not giving half value for Regule, obliged the adventurers to decline a very uſeful and profitable buſineſs and employ for this country. For my part, I think the gentlemen concerned, ſhould have advanced their undertaking, in proportion to the backwardneſs backwardnefs of the Copper companies, by erecting more furnaces, and running the fame Regule into fine Copper; a circumftance of great notoriety, which might be followed by many good confequences for them and their neighbourhood.

Lead Ore, like that of Copper, as it comes out of the Mine, is very little of it merchantable, or fit for fale or fmelting; the foffils and foil mixed with it, muft firft be feparated by breaking and wafhing, according to the nature, richnefs, or poverty of the Ore.

As for Lead Ore that does not rife very folid, it ought to be bucked and jigged, and very feldom carried to the ftrêke, or ftamps, except it be very fcarce and thin in the ftone; but when it is fo poor as to make bucking and jigging improper and coftly, then it is fcarce worth the trouble of ftamping and dreffing: however, when it is fo treated, the grate of the ftamping-mill fhould be yet coarfer than for Copper Ore; becaufe Lead Ore breaks into Facets or flakes, and is thence liable to float away and be loft, even with a very eafy ftream of water. The method of jigging has been ufed a long time in the Lead Mines in Cornwall, though but very lately in the Copper Mines, and they find it to turn to good account both in the one and the other. There can be no doubt, that the Cornifh were almoft entirely obliged to the Derbyfhire and other Lead Miners, for the beft method of dreffing Copper Ores in the firft place; which I fuggeft from the antiquity of Lead Mines in the northern counties, and the much later difcovery of Copper Ore in Cornwall: to which we muft add, that the great fimilarity in the nature and gravity of Copper and Lead Ores, would naturally incline us to ufe one and the fame method for their purification. Neverthelefs, it muft be allowed, that the great varieties of Copper Ores in Cornwall, fome of which require a very nice management in dreffing, have given her Miners a preeminent judgment in that matter, which is warranted by continual obfervation and experience.

But when Lead Ore rifes rich, in large folid pieces, it is broke with a hammer into cubes, from half an inch to one inch of a fide; and this is called Bing in Derbyfhire, but in Cornwall it is ftiled Cobbed Ore. Such part of the Ore which is too impure for bing, is further beaten down with a broad headed hammer called a Bucker, according to its degree of mixture with foffils, &c. which this beating is intended to break off, and

and prepare for ſeparation in water. This, with what was neceſſarily broken to an under-ſize in making bing, they term Knock-bark, i. e. Bucked Ore; which being put into a wire ſieve, and waſhed in a kieve or vat filled with water, the Ore preponderates in the ſieve according to its ſpecifick gravity. Thus the ſmaller parts of the Ore go through the meſhes of the ſieve into the vat, the larger parts reſt on the bottom of the ſieve, and the foſſil part forms a ſtratum above the Ore, which is taken off with a ſemi-circular flat board or hand ſhovel called a Limp, and is thrown away; and the Ore remaining in the ſieve, thus ſeparated, is called Peaſy. Thoſe particles which paſſed through the meſhes of the ſieve, in ſeparating the peaſy from the foſſils, with all ſuch ſmall particles of Ore as have been pulverized in getting or dreſſing, together with thoſe in the waſte hillocks, (halvans and henaways) is again waſhed over in the ſieve and vat, once, twice, or three times, in order to ſeparate and cleanſe the Ore, which they call Smitham. In this manner are formed the three aſſortments of Lead Ore, viz. Bing, Peaſy, and Smitham. Now in Cornwall theſe three ſorts are generally mixed together for ſale; before which, we call the Bing, Cobbed Ore; and the Peaſy and Smitham, Jigged Ore, the Peaſy being firſt Bucked. So much in general do the methods of dreſſing Copper and Lead Ores agree, that in the foregoing account they differ in nothing but terms of art.

There is another method of dreſſing very tender Copper and Lead Ores, ſpeedier than bucking, viz. in dry ſtamps, where the Ore has no water to carry it through a grate, but it is ſtamped dry or a little moiſtened. In dry ſtamping, it falls out of the mill, partly in groſs lumps; and one attends who with a ſhovel throws it on a proper ſized hurdle, through which the ſmaller pieces fall; and the larger that run down to the foot of the hurdle, being pounded ſmall enough to paſs through the hurdle likewiſe, the whole is dreſſed and cleanſed by jigging as before.

When the Ores of Copper or Lead are dreſſed and made ſaleable in Cornwall (for Lead Ore is diſpoſed of in a different manner in Derbyſhire, and the northern counties) the piles or heaps are either kept ſeparate for a market, if the quantities are large; or elſe the different ſorts are well mixed together in one pile, very rarely exceeding one hundred and eighty or two hundred tons in one parcel, and from thence, down to one hundred, eighty, ſixty, fifty, forty, twenty, ten, five, or even one ton, if the feller pleafes, which is feldom the cafe, and never for his advantage. If a Mine has four hundred tons of Copper Ore dreffed ready for fampling, the managers may divide one half of the quantity, for inftance, in two parcels of one hundred tons each, and the other two hundred tons thus; one parcel of eighty, another of fifty, another of forty-two, another of twenty-one, and the laft may be a fmall parcel of poor ftamped Ore computed feven tons, in all, four hundred. But the reader is not to underftand, that thefe different parcels were ever mixed with each other: they may belong to feparate takers upon tribute each parcel, they may lie at feveral diftances from each other, and be of very unequal value; for the firft hundred tons may fell for four pounds ℔ ton, the next for five pounds ten fhillings, the eighty for fifteen pounds ℔ ton, the fifty for eight pounds five fhillings, and fo on of all the reft. It is very common, however, for tributors to mix their Ores with the owners, or with each other of their fellow tributors, fo that the Ores of four or five different fets of people may be all mixed together to make one fample for conveniency of fale, purfuant to the directions of the managers or captains of the Mine, previous to which, their feparate parcels muft be nicely weighed and private famples taken: but I have illuftrated this matter in book iii. chap. iv.

A dreffed parcel of Ore, before the day of fampling, is very well mixed by feveral men, who turn it over again and again, a perfon ftanding on the top of the pile or parcel, who fpreads every fhovelful circularly, and as equally as he poffibly can, fo that in fact, it is mixed with great exactnefs. This parcel, if lefs than ten tons, is divided into three Doles or piles; if above ten, into four Doles; and if ever fo many more than nineteen tons, it is divided into fix Doles; and then it is ultimately ready to be fampled.

Now when the famplers meet upon the fpot according to appointment, either of them, indifferently, fixes upon the one-fixth, one-fourth, or one-third Dole of a parcel according as it is great or fmall, to take their famples from. The Miners then cut or part that Dole athwart and acrofs down to the ground, fo that is divided nearly into quarters, by thefe tranfverfe channels which are cut through it. Then a fampler with a fhovel pares down a little of the Ore from all parts of the channels, to take as equal and regular a fample throughout the whole, as he can, to the amount of two or three hundred weight, which is carried to a clean floor or laid on boards, and there well and regularly mixed in a ſmall heap by itſelf. Next, a ſampler cuts this alſo into quarters, ordering any two of the oppoſite or adverſe quarters, to be returned to the great Dole from whence they were brought. The remaining half he ſtill mixes and quarters, until it is brought to a ſmall compaſs or quantity, when it is ſifted through a ſmall coarſe wire ſieve; and the larger ſtones which cannot paſs through the ſieve are broken with a ſledge or flat polled hammer till all will paſs through the meſhes. After this, he mixes it very curiouſly three or four times over; and ſo quarters and remixes it as before, until it is reduced to a ſmall quantity. Laſtly, he puts about a pound or two of it in a ſmall bag, which is a ſample of the whole parcel. Each of his brother ſamplers fills his bag likewiſe, in order to aſſay or prove its value by fire, as ſhall be hereafter ſhewn.

CHAP. III.

A Summary of the Dreſſing of Gold, Silver, Quickſilver, and Semi-Metals.

THE inhabitants of Africa, and of Brazil, dreſs their Gold-duſt in ſmall bowls, after the manner that Goldſmiths waſh their ſweeps; and I ſuſpect, that the Spaniards in Mexico, and on the continent, dreſs their Ore in the ſame way: but the inhabitants of Brazil will ſometimes find a kind of Gold-duſt, ſo very weak and minute, that they cannot ſave it well in bowls. This has obliged them to have recourſe to another method of making the moſt of this very ſmall Gold-duſt, by laying an ox-hide on the ground, with the grain of the hair againſt the water, which paſſes gently over it. On this they ſtir and mix the ſand and Gold-duſt; by which means, the ſmall particles ſink, and are intercepted in the hair of the hide; while the ſand waſhes off. This method ſeems very rational and well contrived; and Sir John Pettus, in his Fleta Minor, ſays, "The Gold-waſhers uſe ſtrong black and ruſſet woollen "cloth for the ſame purpoſe, in like manner."

From the ſeveral methods preſcribed for cleanſing Ores by water, it is eaſy for one who has a tolerable notion of dreſſing Tin

Tin and Copper Ore, thence to conceive, what may be the beſt way of dreſſing Gold, or Silver Ore, conformable to the waſte or mixture which abounds in either. Yet there can be no certain rules preſcribed without ſeeing the matter to be dreſſed, becauſe its plenty or ſcarcity of Metal, the different ſizes, the various quantities of its brood or waſte, may probably cauſe great variety in the methods of dreſſing it; but as rich Ores, on account of their great ponderoſity, are eaſier cleanſed than any others; ſo alſo, in reſpect to their intrinſick value, they require a more curious and artificial management and operation. I have ſeen ſome ſorts of pure Silver Ore, which contained near one half pure ſilver, the waſte being a light Quartz, ſomewhat tranſparent: now to dreſs a quantity of this, I ſhould adviſe its being bucked ſmall, and then I ſhould prefer jigging before any other way of waſhing it. I ſhould chuſe this method of dreſſing a quantity of Gold and Silver Ores, provided they were rich in quality, or contained much Gold and Silver in proportion to the waſte in them; but if there were little Metal in the Ore, ſo that it would not well anſwer the charge of jigging, in that caſe I ſhould rather waſh it in a ſtrêke, on which I would try an experiment of fixing an ox-hide as above, or rather of covering the ſtrêke with a flannel cloth, or the like, to intercept and retain the fine particles of Metal: but this is not to be underſtood of ſuch Gold or Silver as is intermixed with baſe Metals or Minerals; for then the methods of cleanſing Tin, Lead, and Copper Ore muſt be purſued, and afterwards the Gold or Silver may be extracted by fire, S. A.

As for the Ore of Quickſilver, it is generally ponderous, and therefore may be dreſſed like other Ores. Iron Ore, I doubt, will ſcarce defray the charge of cleanſing, and perhaps it needs waſhing but ſeldom, becauſe it often riſes rich with very little mixture.

Thus, according to one or other of the foregoing methods for dreſſing of Ores, may the Semi-metals of Biſmuth, Cobalt, and Antimony, be cleanſed by water, and by comminuting them more or leſs in proportion to their richneſs and ponderoſity. As for thoſe Minerals which are ſoluble in water, as Alum, Copperas, and all Mineral Salts, they muſt be extracted from their impure mixtures by means of water only, in which they muſt be further purified.

BOOK

BOOK V.

CHAP. I.

On the Art of Aſſaying Ores and Minerals; deſcribing the Utenſils and Fluxes for Aſſaying.

IT is not here propoſed, to teach the art of aſſaying Ores, ſo as to determine the quantities of Metal they contain with ſuch accuracy, as is neceſſary for thoſe who buy Copper or Tin Ores, that being a peculiar trade: nothing but inſtruction by a good aſſayer, and much practice in the buſineſs, can make a man a perfect adept in the art. What is intended here, is, only to give the principles of aſſaying, with ſuch an idea of the practice as may help a perſon to attain that degree of proficience which will enable him to form a pretty good judgment of Mineral ſubjects in regard to their contents. And if a man hath a genius for ſuch ſort of enquiries, with that degree of diligence and attention which uſually accompanies it, it is poſſible that what is here ſaid, may open the way for a more ſcientifick and extenſive knowledge and practice of aſſaying, than is at preſent known or uſed in the county of Cornwall; for whoſe uſe this little eſſay is chiefly calculated and recommended.

To the forming a comprehenſive idea of Ores, &c. a man ought to know the natural hiſtory of thoſe things which enter into their compoſition, which are the Metals, as Gold, Silver, &c. and the Semi-metals, Biſmuth, Cobalt, Antimony, &c. Brimſtone is alſo a very common and almoſt a conſtant concomitant of the Metals and Semi-metals in Ores, as well as ſtones or earths, which in Cornwall are almoſt always of the vitrifiable kind, that is, ſuch as run into glaſs with fluxing materials; as the fixed ſalt of vegetables, pearl aſhes, and ſalt of tartar; nitre, diveſted of its acid by means of any inflammable matter; borax, and the calxes of Lead; fluors, or the fuſile ſpars; clays, and ſtones, of the vitrifiable or flinty kind. By reference to book i. chap. iii. of this work, the reader will there find the natural hiſtory

of

of Ores and Minerals, with that of the fluxes neceffary for their fufion and the feparation of the Metals and Semi-metals they contain. I fhall only beg leave, in this place, to add a method of making the white flux for refining of impure Metals; and another method for making the Fluxus Niger, or black reducing flux.

Black Flux or Reducing Flux. Take ten ounces of white tartar, three ounces and fix drams of nitre, and three ounces and one dram of borax. Powder and fift them through a hair fieve. When equally mixed, put this powder into a wide mouthed bottle, well corked for ufe. Though the colour of this is not black, yet it is a moft excellent reducing flux.

The White or Refining Flux. Take two parts of nitre, white tartar one part. Powder them, and throw them by a large fpoonful at a time into a red hot crucible. As foon as a portion of the mixture is thrown in, there will be a violent deflagration: when that is over throw in another quantity, and fo proceed till the whole is deflagrated. The operator muft be careful to prevent fire or fparks falling among the powder, as it will take fire. The matter muft be taken out of the crucible, powdered, and put up as the former. It ought to be well corked, as it is apt to run foon from the moifture of the air. There is yet an eafier way of doing this, which is, to put the whole quantity of the powder into an iron mortar; then to fet fire to it with a red hot poker, continually ftirring it till the deflagration is over. When cold, powder and fift it, &c.

The common wind furnace ufed in Cornwall, is a very good one in general for the purpofe of affaying Metals; and it might be made convenient for cuppelling, if it was contrived fo as to have a fmall reverberatory built on one fide, to take the flame juft as it arifes from the furnace. I have given a fection of the furnace for melting, and the reverberatory for cuppelling, in plate VI, fig. 1, viz. A, the melting furnace for trying Copper and Tin Ores; B, the reverberatory; C, a hole in its fide for introducing the cuppels. The place or opening at C, muft have a door of brick clay exactly to fit it, with a fmall hole in the middle to infpect the ftate of the affay, which hole muft be ftopped with a bit of clay. D, the chimney into which the flame paffes from A over the cuppel in the reverberatory B. E, iron bars or grate of the furnace. F, the afhes pit, the whole length of the building from G to H. A furnace thus

 conftructed,

conſtructed, is, I think, ſufficient for moſt if not all aſſays in Metal.

I ſhall ſpeak of fuel, and the conduct of the fire, when I come to the proceſſes; and ſhall likewiſe treat of the veſſels uſed in aſſaying, and the materials of which they are made: mean while I ſhall firſt give the artiſt a proceſs for diſcovering the contents of a Mineral in the liquid way, or by a menſtruum.

Proceſs I. Calcine the powdered Mineral, or keep it red hot till it ceaſes to yield any ſulphureous flame; and if the white arſenical fumes are diſcharged, it may be the better. The Ore muſt be ſtirred during the calcination, to prevent its running into clots, in which caſe, it muſt be powdered anew. Put this calcined Ore into a phial, and pour on it pure double aqua fortis, or ſpirit of nitre, ſufficient juſt to cover it. Let the phial ſtand on warm ſand, or in hot water, for two hours: if there ſhould be a violent ebullition, and plenty of red fumes, remove and put the phial into cold water, in which it muſt ſtand till cold. Drop ſome of this ſpirit of nitre into water, and if it lets fall a very white ſettlement, the Mineral contains Biſmuth. Pour about as much water into the phial, as ſhall be equal to the quantity of aqua fortis or ſpirit of nitre that was uſed. Set it on the hot ſand or water for an hour; let the phial ſtand till the ſolution is quite clear; then pour it off from the Ore, and drop a ſmall quantity of ſtrong brine into it; if a white matter precipitates, the Ore contains Silver, or Lead, or both: continue to add brine till no more precipitates. Pour the liquor from this precipitate, and waſh it with clean water, letting the water ſettle clear before it is decanted off; add freſh water, and repeat the waſhings till it is ſweet. Melt the precipitate with treble its weight of black flux; and, if there is Lead in it, evaporate the Lead in a cuppel, when the Silver, if any, will be left behind. The Biſmuth that falls, will be carried off with the Lead; but in order to free the ſolution as much as poſſible from Biſmuth, it may be proper to dilute it with more water before the brine is added; and if there is any precipitate, to ſeparate it. Try the ſolution for Copper, by dropping a little of it on a bright piece of Iron; if it leaves a ſtrong full ſtain of Copper, this Metal may be ſeparated from it by powdered chalk; for by gradually adding the powder, in ſome time, on the ceaſing of the violence of effervéſcence, the Copper will precipitate in a green powder, called Verditel. Continue to add the powdered chalk, till no more precipitate falls;

falls; waſh this as the former precipitate, melt it with black flux, and it will be revived into Copper. The ſolution ſhould be kept in hot ſand, or water, during the whole time of the precipitation.

In the above proceſs, the ſpirit of nitre being the proper ſolvent of Silver, Copper, Lead, and Biſmuth, if any of theſe matters are in the Ore they are diſſolved; that is, after the ſulphur is burnt off, which would otherwiſe guard them from being attacked by the ſpirit. It is expedient, that there ſhould be a larger quantity of ſpirit than is juſt neceſſary to diſſolve the Metals, otherwiſe they might precipitate one another; it is therefore right, to taſte the ſolution; and if it taſtes very ſharp and acrid, the quantity of ſpirit hath been ſufficient. To make this experiment as accurate as poſſible, in regard to quantity, the calx ought to be finely levigated in a glaſs mortar; and the affuſion of ſpirit of nitre, and the digeſtion, &c. continued as often, and as long, as any thing metallick can be gotten from the calx.

Proceſs II. To aſſay Pyrites, Marcaſites, or Mundicks, for Gold or Silver.

Light a fire in the wind furnace, with common coal; and when it is got up to a good white heat, place a crucible in it, which ſhould be firſt dipped in water to prevent its cracking; ſurround it with coal almoſt to the brim, and as ſoon as it is of a good ſtrong heat inclining to whiteneſs, put into it the Mundick deſigned to be aſſayed, which ought to be previouſly weighed. Shut the opening of the furnace with the bricks uſed for that purpoſe. Let it remain till it is perfectly fuſed; then pour it into a cone, greaſed, or rather ſmoked by the flame of a candle; when it is cold, knock it out of the cone, and ſeparate the reguline or metallick part from the ſcoria, if any on the ſurface of it. A cone is a hollow veſſel made of caſt Iron. See fig. 2, plate VI.

Proceſs III. The method of ſcorifying this Mundick, or converting all the parts which compoſe it (except the noble Metals) into Glaſs.

Place a crucible of the largeſt ſize, on a piece of brick ſuitable to it, in the middle of the wind furnace. Make a fire round it with charcoal till it is red hot, when common pit-coal may

may be ufed. Then put in the Regulus of the Pyrites or Mundick, with one half its weight of Lead revived from litharge, and as much Glafs of any kind, with as much litharge as Glafs, previoufly mixed together. Raife the fire till all is melted, and the fulphur and arfenick appear to rife through the Glafs a-top, and fly off in a flame. Continue the fire for fome hours, till this appearance ceafes, and the Glafs melts fmooth like oil, when it may be fuppofed the fulphur and arfenick are confumed and the fcorification pretty far advanced. In this part of the operation, it will be neceffary, from time to time, to make frefh additions of litharge to thin the Glafs, which is apt to grow thick and tenacious by the Iron (which is continually fcorifying) mixing with it. When the litharge is thrown in, it ought to be mixed up with the Glafs a-top, by means of an Iron rod. The Glafs ought to be very thin before the whole is poured out; when this is the cafe, pour it out into the greafed or fmoked cone; and when cool, knock it out, and feparate the fcoria from the Lead at bottom. If the Lead is quite foft and malleable, and the fcoria very thin, fo that if a wire was dipped in them, they would have dropped off it like oil, leaving only a varnifhed like appearance on the wire; the operation is well done: but if the Metal is brittle and hard, the operation muft be continued till it is rendered quite foft and malleable. Sometimes it is neceffary to make an addition of frefh Glafs, in order to a complete vitrification of the Iron, but then litharge muft be added at the fame time.

When the Lead is reduced to perfect foftnefs, it is fit for cuppellation. To carry this procefs to perfection, it is neceffary to bring the fcoria to a complete vitrification, when they will be very thin and fhining. They are then to be powdered, and mixed with their weight of black flux, a little powdered charcoal, and one quarter their weight of fea falt decriptated: the whole is to be perfectly fufed, till it flows like oil, when it is to be poured into the cone; and, when cold, the Lead in the bottom, which is like to be in confiderable quantity, muft be alfo cuppellated, but feparately from the other, in order to determine if the firft affay was perfect or not.

The intention of the above procefs, is to feparate the fulphur and the arfenick from the Mundick; and to convert the Iron, which makes up a great part of this compound, into fcoria; and finally to vitrify it fo, that the Gold and Silver it may contain fhall be abforbed by and left in the Lead; which I think is perfectly

perfectly well done by this procefs. The fulphur and arfenick, are continually flying off through the Glafs, which is likely to detain any of the nobler Metals, which the arfenick might otherwife volatilize; at the fame time, the Iron which was mineralized by them, burns to fcoria, and rifing a-top of the metallick part mixes with the Glafs, and is vitrified with it; the Mundick at bottom grows more and more metallick, and, as I apprehend, the Lead, if not entirely, is at leaft greatly mineralized by the fulphur and arfenick. The Iron and Lead, in this Mineral ftate, are mixed; but the Iron parting from thefe matters eafier, as well as attracting them ftronger, than the Lead, difcharges them up through the Glafs, and is gradually turned into fcoria, till the whole of it is feparated from the Lead, leaving with it the nobler Metals it contained.

The only hazard of miffing in this procefs, is from the veffels being corroded by the Glafs of Lead, which is very penetrating, when brought to that thinnefs by the litharge which is neceffary; but this may be effectually prevented by the ufe of a porcelain or china-ware crucible, which as it is a new invention, and may be of great ufe to the curious in Metallurgy, without remarking on what others have done, I fhall here give it to the publick in few words.

Procefs IV. Whoever hath been converfant in Mineral chymiftry, muft know, that veffels which will hold Glafs of Lead, prove a great defideratum. Now the micofe clay, which is one part of china ware, is known to be abfolutely unvitriable; for though mixed with an equal part of vitriable ftone, it ftands the greateft heat that art knows, without being vitrified.* I believe all the grouan clays would anfwer to make the veffels in queftion; and, I know that the porcelain clay at St. Stephen's will. The compofition I would recommend, is two parts of the wafhed clay, and one part of the gravel it contains, ground to a very fine powder, mixed and made into a pafte. Let a potter form them into the fhape of coffee difhes of a moderate thicknefs, and of different fizes, according to the purpofes they are defigned for. They muft be burned in a crucible, or with crucibles, or porcelain, if you are in the neighbourhood of a factory of either kind. The fire muft be full as ftrong as is neceffary to burn china ware or crucibles; but if one hath not the advantage of a neighbouring pottery, the higheft heat that

* See book i. chap. iii. upon Steatitæ, or Soap-rock.

can be given in a ſmart wind furnace, is ſufficient. When burned, they are a true unglazed porcelain as it is poſſible; the St. Stephen's clay without mixture, may make the ſtrongeſt veſſels; it might be tried: but I know common porcelains anſwer extremely well.

As theſe veſſels will by no means bear an open fire, they muſt be guarded: the beſt way of doing which, is to place them in crucibles made round, and about two-thirds of an inch, or an inch wider. Lay in the bottom of the large crucible the thickneſs of half an inch of flint ſand; if this cannot be had, Quartz, or (as it is improperly called in Cornwall) Spar, may be powdered and ſifted through a hair ſieve: fill up the vacancy between the two crucibles with the ſand or powder, and let the outſide crucible have a cover made to it exactly like that of a teapot, and the apparatus is finiſhed. See plate VI, fig. 3. This apparatus muſt be fixed on a conical baſe made of two parts pipe clay, and one part ſand; the ſhape of it is to be ſeen plate VI, fig. 4, a little excavated at top, to let in the crucible that it may ſtand ſteady.

I have thought proper to give this proceſs on Pyrites, as there has been much contention about the matter; people will now have it in their power to know whether or not they are of any value.

Any Ore that is ſuppoſed to contain Silver, or Gold, mixed with a proper quantity of litharge, with revived Lead at bottom, and a mixture of Glaſs, if the Ore has no vitrifiable ſtone in it, may be tried the ſame way. The want of vitrifiable ſtone or earth, may be known by the ſcoria, which will be tough and metallick, not glaſſy.

Litharge is eaſily revived, by mixing it with a proper quantity of black flux, and a little charcoal duſt, and melting the whole in a ſtrong fire, till the ſurface melts ſmooth and equal, without bubbling.

Proceſs V. Cuppellation; and the ſeparation of Silver and Gold by Aqua Fortis.

The veſſels uſed in this proceſs, are called Cuppels, and are formed ordinarily of bones burned white and powdered, or of the aſhes of vegetables from which the ſalts have been thoroughly ſeparated

ſeparated by water. But for the formation of cuppels, I refer to Cramer's Art of Aſſaying, or Maquer's Chymiſtry, where the manner of doing it is very rightly directed. Some of theſe cuppels are made in moulds, and others in Iron rings. The former are inverted fruſtums of a cone, much about the ſize of fig. 5, plate VI, which is a ſection of a cuppel. The others are formed in Iron rings, larger or leſs at pleaſure. The method of forming them, is to fill the ring with the bone or other aſhes, or a mixture of both. The aſhes are brought much to the ſame temper of moiſture with water, as ſand is for caſting Metals: the ſand is then beat down as cloſe as poſſible, and a hollow place is formed in the cuppel, for holding the Metal. Theſe cuppels are made either round or oblong. The kind of fig. 6, plate VI, may be uſed, four or five inches wide; which will work off four or five pounds of lead.

As the cuppelling furnace will hold ſeveral teſts, when one wants to cuppel, it is right to put three or four dry cuppels into the reverberatory with their bottoms upward. Light a fire in the wind furnace, and raiſe it gradually till the cuppels are red hot; then ſet one or more of them with their hollows upward, and with a ſmall Iron ladle put the Lead to be tried into one of the cuppels: the Lead is uſually beat flat, and cut into pieces, which will melt immediately and contract a ſcum, and if the fire is ſufficiently ſtrong, in ſome little time the ſcum will ſeparate, and diſcover the melted ſurface of the Metal, as bright as Quickſilver. If the proceſs goes on well and right, there will be little particles or drops reſembling oil, continually riſing on the ſurface of the Metal, which will be thrown off to the ſides, and abſorbed by the cuppel. The fire is to be conſtantly and uniformly kept up, ſo as to keep the aſſay in this way of working, till the Lead is all converted into litharge, and the Silver or Gold ſets on the cuppel. Expertneſs in this proceſs is only attained by practice. Cramer's deſcription of it, is very exact; but as the furnace here directed, is different from his, it is neceſſary to obſerve, that if the fire wants to be ſuddenly quickened, freſh lumps of coal, or ſmall pieces of dry wood, are to be thrown into the wind furnace, by juſt opening one of the bricks that cover it. When the aſſay is too hot, a covering brick or two may be taken off, or even the ſtopper in the reverberatory left open, till the heat is ſunk to a proper temper. The marks of too great or too ſmall a degree of heat, are accurately deſcribed by Cramer.

Weigh

Weigh the grain left on the cuppel, and fee what proportion it bears to the Mundick affayed; from whence it is eafy to calculate the quantity of noble Metals, in any given quantity of the Mundick. Lead reduced from litharge is ufed in this operation, as it contains no Silver, at leaft fo inconfiderable a quantity, as is not worth attending to.

Procefs VI. To difcover, whether the product of the affay contains Gold, and the quantity it contains.

Pour on the grain, four or five times its weight of proof aqua fortis; place the phial on warm fand, and if the Silver entirely diffolves without any black fediment, it contains no Gold; but if there is any black fediment, this is Gold. Pour the folution of Silver from it, and pour water on it, fhaking the whole; let this water fettle, and then decant it off into the folution of Silver; repeat this till the water has no bitter tafte. Wafh out the black powder into a fmall tea difh; and when it is fettled, pour off the water from it, and dry this powder of Gold by placing the difh on hot fand. Weigh the powder, and make the calculation. If the Gold is in fo fmall a quantity, that you have no fcales or weights nice enough to weigh it, the Lead muft be enriched by the operation of fcorification, being repeated with the fame Lead, on three or four more parcels of frefh Mundick.

If the grain or bead of Metal contains much Gold, fay as much, or more, or even one-third of Gold, the aqua fortis will not diffolve it; in which cafe, three or four times its weight of Silver (which contains no Gold) may be melted with it, or fo much as will render it diffolvable in the aqua fortis. The Silver may be precipitated from the folution, by evaporating the water from it in a fuitable china-ware veffel fet in hot fand, till the quantity is properly reduced; that is, till the water ufed in wafhing the Gold is moftly evaporated from it; when by putting clean bits of Copper into it, the attraction between the aqua fortis and the Copper, being ftronger than with the Silver, this latter will be precipitated in the form of a white fhining powder, to be feparated from the bits of Copper. If clean bright pieces of Iron are put into the folution, the Copper will be precipitated; and alkali falt will precipitate the Iron. Wafh this precipitate till the water is no longer faline; evaporate the whole, and what is left will be a true good nitre, formed by the

the ſpirit of nitre, and the pot-aſh ; the vegetable alkali being the baſis of nitre.

Proceſs VII. Proof Aqua Fortis.

Take any quantity of good aqua fortis, which will diſſolve Silver ; drop into it a few drops of a ſaturated ſolution of Silver : if there appears to be any precipitate or cloud of a white colour, as there will if the aqua fortis has ſpirit of ſalt in it, which I believe is always the caſe ; if this precipitate falls ſoon to the bottom, it is proof the aqua fortis contains much ſpirit of ſalt, and one may be bolder in dropping in the ſolution of Silver ; but if it is thin and light, it is neceſſary to proceed with more caution. Let this milkineſs ſettle ; and to a ſmall quantity of the aqua fortis in a phial, add a drop of the ſolution of Silver ; and if there ſtill appears a milkineſs, more of the ſolution may dropped in, always aiming to add no more of the Silver ſolution, than is neceſſary to ſeparate the whole of the ſpirit of ſalt from the aqua fortis, which may be known by adding a drop of the ſolution to a little of the aqua fortis in a phial ; for if the aqua fortis is proof, it will continue quite clear without the leaſt milkineſs.

There is an eaſier way of preparing proof aqua fortis, which is by putting a bit of Silver into it, and ſhaking it ſeveral times in a few hours ; and if, the next morning, it is ſettled quite clear, and any of the Silver is left, it is proof. The only queſtion is, whether it doth not contain Silver ; to determine this, drop a few drops of it into filtered brine, and if there ariſes no cloudineſs in the mixture, the aqua fortis contains no Silver.

Spirit of ſalt will not diſſolve Silver ; but being diſſolved in aqua fortis, there is a ſtronger attraction between the ſpirit of ſalt and the diſſolved Silver, than between it and the aqua fortis, as it diſlodges the ſpiritus nitri, and unites with the Silver into a ſalt that is not diſſolvable in water, and ſo ſinks to the bottom in a white curd called Luna Cornea, which may be reduced into Silver with pot-aſh, by being melted with it ; and if the pot-aſh is not in too great a quantity, it will be converted into a ſea ſalt, with a vegetable alkali baſis ; by which it appears, that the ſea ſalt was decompoſed, or ſeparated from its mineral alkaline baſis, in the operation of precipitating the Silver. What is called the Mineral Alkali, or Baſis of Sea Salt, is of the

 ſame

ſame nature with the Barilla or Soda, uſed in the preparation of French and Spaniſh ſoaps.

I have been thus particular in deſcribing the proceſs of preparing proof aqua fortis, as it is a very neceſſary menſtruum in metallurgical experiments.

As it is poſſible the Mundick tried, may contain Copper in ſo large a quantity as not to be entirely ſcorified by the above operation, but may poſſibly remain on the cuppel in a conſiderable quantity; in this caſe, the bead muſt be diſſolved in proof aqua fortis containing no Silver, or that yields no cloud dropt into clean brine. If this bead contains Gold, it will remain undiſſolved in a black powder as is ſaid above; waſh it, and add the water to the ſolution, into which, drop brine as long as any white precipitates: this is the Silver in the ſhape of the Luna Cornea, and when waſhed and dried may be weighed. I think four parts of it contain three of Silver, or thereabout.

Proceſs VIII. To aſſay Tin for Gold.

To eight ounces of melted Antimony, put two ounces of the Tin to be tried; keep them together in a moderate fire, till they melt together and flow like oil, without the leaſt bubbling or effervеſcence, which operation may take an hour. If the mixture grows thick, freſh Antimony is to be added, till it melts perfectly thin or fluid; then pour it out into the Iron cone, and when cold ſeparate the bright antimonial regulus at bottom, from the ſcoria at top: ſet by theſe ſcoria. Heat a cuppel made of crucible clay, or the bottom of a crucible, reduced to the ſhape of a cuppel (theſe veſſels are called Teſts) in the reverberatory, till it is of a ſtrong red heat inclining to white; place the regulus of Antimony in it, which will inſtantly melt. Direct the noſe of a kitchen bellows on this teſt, and keep up a continual blaſt on the regulus (which will evaporate in thick white fumes) till it is reduced to one quarter or leſs of its original weight. Take out the teſt and let it cool; ſeparate the remaining regulus from it, and melt it in a crucible. Throw on it twice its quantity of nitre; and when the deflagration and fumentation are over, pour it out into the cone. If there is any Gold left, and this Gold is fine, the operation is complete; but if there is nothing left at the bottom of the yellow glaſſy ſcoria, the Tin contains no Gold. If there is a ſmall button of brittle Metal, or Metal not ſufficiently malleable,

add

add equal parts of nitre and borax, and repeat the operation, till the Gold is quite fine ; when it is to be weighed, and the proportion it bears to the Tin aſſayed, determined.

In this operation, the ſulphur which mineralizes the Antimony, having a greater attraction with the Tin, than with the regulus of Antimony, deſerts the regulus, and lays hold of, and mineralizes the Tin, with which it aſcends among the melted Antimony ; whilſt the regulus ſeparated from the Antimony, deſcends, and mixes with the Tin at bottom. This proceſs goes on till the whole of the Tin is mineralized by the ſulphur, and ſomewhat a greater quantity of the regulus ſeparated and precipitated ; if the Tin contains any Gold, it will be mixt with this regulus, as ſulphur cannot mineralize it. If there is any Silver, this will be mineralized, and raiſed among the ſcoria, which conſiſt of the Antimony in its Mineral ſtate, and the Tin reduced to this ſtate ; the regulus containing the Gold, being volatile, is evaporated in white fumes, by the ſecond operation, whilſt the Gold is left : but as it is difficult to bring it to perfect fineneſs this way, nitre is uſed in the finiſhing operation, which immediately calcines the regulus. In this operation, the ſpirit of nitre evaporates along with the phlogiſton of the regulus, and the alkaline part of this, together with the reguline calx, melts into glaſſy ſcoria of an amber colour, leaving the Gold untouched by the nitre, which cannot diſſolve it.

Proceſs IX. To try the firſt ſcoria for Silver.

Melt the firſt ſcoria, conſiſting of the mineralized Tin and Antimony, in a crucible ; throw powder of nitre on them, and there will then be a conſiderable deflagration ; continue to throw in more nitre till the deflagration ceaſes, and when the matter in the crucible melts like oil, pour it into the cone, knocking it gently that it may ſettle. When it is cold and ſtruck out of the cone, carefully examine the apex of the melted ſcoria, where the Silver will be found if the Tin contained any.

In this proceſs, the phlogiſton of the ſulphur is carried off by the ſpirit of nitre ; and the other part of it, viz. the vitriolick acid, is attracted by, and united with, the alkaline baſis of the nitre, forming with it a true ſal polycreſton, that ſwims at the top of the melted ſcoria, which by this proceſs, are converted into

into a compound crocus metallorum, confifting of the calcined Antimony and Tin. The Silver not being calcinable, when the fulphur which mineralized it is feparated by the nitre, it regains its metallick form, and falls to the bottom of the cone.

The compound crocus metallorum, and the amber fcoria, may be reduced into a metallick form, by being mixed with a proper quantity of black flux, and melted in a crucible; but not without great lofs of the regule. This procefs for the feparating Gold from Tin by Antimony, may be applied to Copper, or any other Metal.

Procefs X. To affay Copper Ore.

Powder the Ore and fift it through a hair fieve; fhake and mix it together, that every part of the powder may be alike, in regard to its metallick contents: form this powder on a piece of paper into a bed of half an inch thick; then weigh off a troy ounce, or ounce and quarter of it, from different parts of the bed or heap: and in order to affay it, the Ore is firft to be calcined, in the following manner:

The wind furnace having been before well heated, is to be filled with fea coal, reduced to the ftate of charcoal, or as it is ufually called, coakt or charkt. A crucible of the largeft fize for affaying, is then placed in the furnace, fo that the top of it fhall be a little beneath the top of the furnace. It is very proper to place one layer, or a few pieces of raw coal, round the top of the crucible, to keep down the flame and heat, which would otherwife incommode the operator in the calcination. The Ore may now be put into the crucible, and fome of the covering bricks put on the mouth of the furnace to raife the fire; but this muft be done gently. As foon as the Ore is obferved to be of a dufky red, it is time to begin to ftir it, to prevent its melting and running into lumps, which muft by all means be prevented, both by ftirring, and a proper regulation of the fire. The Iron rod ufed in ftirring, fhould be about two feet and a half long, and as thick as the end of the little finger, the one extremity of it flattened and formed like the toes of a pair of tongs, fo as to fuit the bottom of the crucible. With this rod the Ore is to be ftirred brifkly from time to time, fo as to prevent its melting, or running into lumps; and if it fhould appear difpofed to do this, it muft be ftirred very brifkly, till the appearance ceafes, and the Ore is again reduced into a powdery form.

form. It will not be neceffary to ftir the Ore continually ; but when you ceafe to ftir, the rod muft not be taken out of the crucible but left in it, the upper end refting on the bricks of the chimney.

In the beginning of the calcination, a large quantity of fulphureous and arfenical fumes will be difcharged from the Ore ; and moft Ores, at this time, emit alfo more or lefs of a fulphureous flame. As the Ore parts with thefe volatile matters, it grows lefs fufible, fo that the fire may be fuffered to encreafe a little, in proportion as the Ore is lefs liable to melt. The operation muft be thus continued, till the Ore emits no longer any vifible fumes. When the crucible is taken out of the fire and fmelt at, if it yields no fmell of fulphur, even when it hath been expofed to a ftrong red heat, a little inclining to white, then it is fufficiently calcined. This procefs generally takes three quarters of an hour, and the fire muft be often renewed by adding frefh charks, and raw coal.

In this procefs, the Ore is freed from the fulphur and arfenick which mineralized it, and is now reduced to the Metals and ftony fubftances ; but as the Metals cannot be collected by fufion into a body, as the ftony parts are infufible, this makes it neceffary to ufe fuch things as will turn thefe ftony matters into Glafs, by the following procefs of Scorification.

Procefs XI. Suppofing the quantity of Copper Ore made ufe of, to be one ounce, mix with it one ounce and a quarter, good weight, of black flux, and half a thimble full of powdered culm ; put thefe into the crucible the Ore was calcined in, and cover them with nearly half an ounce of fea falt. Fill the furnace with charks, and place the crucible in the furnace, furrounding it with charks to the brim. After you have covered it with a cover, made of the fame compofition with the crucible, put on the covering bricks on the mouth of the furnace, when the fire will rife, and the matters in the crucible will be heard to melt and boil. When thefe appearances have ceafed for fome time, remove the bricks, and infpect the matters in the crucible ; if the furface is agitated, and the boiling and fermentation continue, the fcorification is not complete. If the fire wants mending, mend it ; place the crucible fecurely, clofe the furnace, and continue the fire, till the contents of the crucible flow like oil. Take it out of the furnace, and fuffer it to cool ; when cold, break the crucible, and feparate the Metal at bottom, from the ſcoria. If theſe appear to be quite glaſſy, lucid, and black, and if they contain no grains of Copper, the ſcorification is well done.

In the above proceſs, the nitre and tartar are converted into an alkaline ſalt, which being rendered ſtill more vitreſcent by the borax, convert the ſtony matters contained in the calcined Ore, together with a part of the Iron in it, into a true glaſs, to which the blackneſs is given by the Iron. As this glaſs is very fuſible and fluid, the grains of Copper now reduced to Metal, eaſily find their way through it, and unite at the bottom into one piece of Metal. The ſalt is added as it contributes to vitrification, and prevents the matter from riſing in the pot, and leaving grains of Metal on its ſides, which would falſify the aſſay. The powder of culm is put in, to ſupply phlogiſton, after what the tartar contained is burned off; and if the operation is continued after this, there is danger of the Coppers being burned, and deprived of its phlogiſton; in which caſe, the aſſay will be covered with a red ſhining heavy friable ſubſtance, which is the calcined Copper melted: to guard againſt this, the powdered culm is added.

The quantity of flux may be varied, according to the richneſs of the Ore. Very rich ones will require much leſs than what is ordered; nothing, however, but practice and experience, can enable a perſon to fix the quantity of flux requiſite. The furnace for ſcorification ought to have a ſmart draught; for if the operation takes up much time, the aſſay is apt to burn; about fifteen or twenty minutes is ſufficient for the moſt part, if the furnace is a good one.

The lump of Metal from the firſt melting is ſcarcely ever fine, being mixed with Iron, Lead, Tin, or poſſibly with all theſe Metals; therefore to ſeparate them, it muſt be refined, for which the following is the proceſs:

Proceſs XII. Refining the impure Copper.

Fill the furnace with charks, and place a crucible of the ſecond ſize in it. Let the fire riſe till the bottom of the crucible is white hot, when the button of Copper is to be put into it, by means of a ſmall pair of forceps or tongs purpoſely contrived for it. As ſoon as the Copper is ſeen to melt, throw on it, by means of a ſmall Copper ſcoop, about as much white flux as

will

will lie on a half crown ; there then will be a great boiling and fermentation in the crucible : when this ceafes, pour it into the ingot firft fmoked or greafed ; and when the whole is fet, plunge it in water to cool it ; feparate the fcoria, and fet them by in a ladle. If the button of Copper is not fine, this operation muft be repeated until it is, which is known by the brightnefs of the colour, its malleability, and breaking with a fine grain. This operation is generally repeated three or four times, or more, before the Copper is quite fine.

As the white flux contains a large quantity of nitre, and the aqua fortis in it corrodes Iron and Tin more readily than it does Copper, thofe Metals are turned into calx by it, and feparate in the form of fcoria along with the flux : fome of the Copper, however, is always corroded, and turned into fcoria ; therefore, to render the affay perfect, this muft be recovered and brought to Copper. In order to this, the next operation or procefs is neceffary, which is

Procefs XIII. The reduction of the fcoria ; and alfo the refining the prill.

Dry all the fcoria of the former procefs which were fet by in the ladle ; beat them to a powder in the fmall Iron mortar, and mix with them about their own weight of tartar powdered, and a little powdered culm : cover them with a layer of falt, and melt them as in the procefs of fcorification. When the whole is melted perfectly, and flows like oil, pour it into the fmoked ingot. The reduced Copper, or as it is more ufually called by the Cornifh affayers, the Prill, will be found beneath the flagg. This, too, is always impure Metal, fome part of the other Metals being reduced along with the Copper ; the prill muft therefore be carefully refined as above, with the white flux, adding fome falt immediately after the flux is thrown in. The refined prill is then to be added to the button of Copper, and both weighed, to determine the quantity of fine Copper, which the Ore contained ; from whence a calculation may be made, of the contents and value of a ton of Copper Ore.

The refining the prill is a very nice operation, which the Cornifh affayers perform with fingular expertnefs. They judge the effect of their fluxes very nicely, and help them by keeping the affay in the fire for fome time before they pour it ; for fire has the fame effects with nitre in reducing the imperfect Metals

to

to a calx, only it does it flower: the Iron, Tin, and Lead, calcining quicker than Copper, the effect of fire in refining is very evident. Neverthelefs, the fuccefsful management of it, can only be attained by attention and experience.

In Copper affays, the cone is not ufed, but an ingot of a peculiar kind. Hollows of a fpheroidal form, are made in a piece of Iron or Steel about an inch thick. Thefe excavations are polifhed very fmooth, and the utenfil hath a handle formed out of it, fee fig. 7, plate VI. The hollows contain about half an ounce of water, and are nearly an inch and quarter diameter. Some fmoke thefe hollows with the flame of a candle, and others rub them with greafe, or a rag inclofing fome tallow, rofin, or wax.

Procefs XIV. To affay Copper Ore the regule way.

Pulverize, fift, and mix the Copper Ore, as in the tenth procefs; then take the the fame quantity of Ore, with an equal part of common powdered black glafs, about a fourth or a fifth part of nitre, and half as much borax: mix and put them all together in the crucible, covered with one quarter of an inch thick of common falt. Melt thefe in the ftrongeft fire you can raife in the wind furnace till they flow freely, which will take fome time longer than a fample of calcined Ore. When cool, break the crucible, feparate the regulus from the fcoria, pulverize it, and then proceed exactly in the fame manner as with a calcinable Ore, ut fupra.

Now, in order to calculate the value of a ton of Copper Ore by the produce of an affayed troy ounce, you are to remember, that if one ounce of Ore makes one pennyweight of fine Copper, it will be one part in twenty, five pennyweights will be five parts in twenty, and fo on: therefore, a perfon who is familiar in the bufinefs, may know the value of a ton of Copper Ore off hand, by only afking, how many parts in twenty fuch a fample has produced. But this valuation of an affay depends entirely upon a given ftandard price for the ton of fine Copper, be it either ninety, ninety-fix, one hundred, or one hundred and five pounds fterling. Of courfe, every pound or twenty fhillings that the ftandard rifes or falls, will make a difference in the affay of one fhilling or a twentieth in every pennyweight, and a halfpenny in every grain: as for inftance, one pennyweight, one grain, at ninety-five the ftandard, will make the produce

equal

equal to four pounds fifteen ſhillings the pennyweight, and three ſhillings and eleven pence halfpenny the grain; but if the ſtandard is ninety-ſix, the produce muſt be valued at four pounds ſixteen ſhillings the pennyweight, and four ſhillings the grain. Three pennyweights and three grains at ninety-five the ſtandard, will amount to ſixteen pounds ſixteen ſhillings and tenpence halfpenny, and at ninety-ſix will riſe to ſeventeen pounds.

This mode of calculation being apprehended by the reader, I will proceed to a few examples by the rule of practice, which will ſet the matter in ſo clear and eaſy a light, that any perſon may calculate an aſſay of Copper Ore without the leaſt difficulty.

Suppoſe one troy ounce of Copper Ore produces an aſſay of fine Copper that weighs — at ninety pounds the ſtandard value of one ton of fine Copper, I firſt multiply the three pennyweights by four pounds ten ſhillings the ſtandard; for ten times three ſhillings are thirty ſhillings, and four times three pounds are twelve pounds, and with the twenty ſhillings from the place of ſhillings make one pound more, equal to thirteen pounds ten ſhillings: ſo that three pennyweights of fine Copper at ninety, is worth thirteen pounds ten ſhillings the ton: but here are nineteen grains unaccounted for in that price; therefore, I ſay, twelve grains are one half of a pennyweight, equal to two pounds five ſhillings; ſix grains, the half of that, are equal to one pound two ſhillings and ſixpence: and the one grain remaining, is equal to ninety halfpennies; for, as I have ſaid before, one grain is valued at ſo many halfpennies, as the ſtandard is pounds; therefore one grain is equal to three ſhillings and ninepence. By adding the whole together; I find the aſſay of three pennyweights nineteen grains, at ninety, is worth ſeventeen pounds one ſhilling and threepence ℔ ton of Copper Ore. Theſe are the groſs proceeds; but as there is an expence upon the bringing this ton of Ore into fine Copper, ſuch as carriage of the Ore to the coal by land or ſea, or both, furnaces, labour, coal to ſmelt it, &c. it muſt be deducted before we can fix the nett value thereof. Theſe returning charges are commonly rated at three pounds ℔ ton one with another; ſo that, of conſequence,

Dwts.		Gr.
3		19
£4	10	
£13	10	
2	5	
1	2	6
	3	9
£17	1	3
3		
£14	1	3

 one

one hundred tons of Copper Ore will require three hundred pounds expence to bring them into fine Copper; and the above ſeventeen pounds one ſhilling and threepence will be reduced to a nett value of fourteen pounds one ſhilling and ſixpence; it being cuſtomary to reckon no pence below ſix.

Neverthelefs, in ſome Ores, theſe returning charges at three pounds are over much; for if it requires but that money to ſmelt Ore of fifty ſhillings nett value ℔ ton, it certainly cannot take the ſame to ſmelt Ore of thirty or forty pounds; as many of our rich gray Ores (which are naturally regulized) and native Copper demand but two or three flowings to be thoroughly refined. All theſe things are properly judged and conſidered by the purchaſers, who may add or diminiſh their eſtimates of returning charges as they chuſe, the ſeller being generally as ignorant of the whole as any perſon unconcerned in the affair. I ſhall ſubjoin two or three aſſays at different ſtandards, which may be calculated by the foregoing rule; premiſing, that if the reader would know the quantity of Copper Metal in one ton, or any given number of tons of Copper Ore, he muſt divide four hundred and eighty by the produce of the aſſay, and the remainder by twenty, and that will ſhew what quantity of Ore will make a ton of fine Copper.

	Dwt.	Gr.		
An aſſay of fine Copper weighs	1	19		at 95 the ſtandard.
	£4	15		
	2	7	6	
	1	3	9	
		3	11½	
	£8	10	2½	
Deduct for returning charges	£3			ſuch as ſmelting, &c.
Nett value	£5	10	6 ℔ ton.	

An

	Dwts.	Gr.		
An aſſay of fine Copper weighs	4	13		at 96 the ſtandard.
	£4	16		
	£16			
	2			
	1	4		
	2	8		
		4		
	£21	16		
Deduct for returning charges	£3			
Nett value	£18	16		℘ ton.

	Dwts.	Gr.		
An aſſay of fine Copper weighs	2	7		at 100 the ſtandard.
	£5			
	£10			
	1	5		
		4	2	
	£11	9	2	
Deduct	3			
Nett value	£8	9	6	℘ ton.

Proceſs XV. To aſſay Lead.

If this Ore is pure, that is, free from Mundick or the like, the proceſs is very eaſy. With an ounce of the powdered Ore mix about eight or nine pennyweights of freſh Iron filings. Melt the whole together in a pretty ſtrong fire till it flows perfectly thin; then pour it into a greaſed cone or ingot; and, when cold, ſeparate it from the ſcoria at top. If the ſeparation ſhould be difficult, put the whole into an Iron ladle, and when the ladle is red hot, the Lead will melt, and run from the ſcoria, and will pour out perfectly fine Metal.

As through the violence of the heat in the firſt melting, the Lead will take into it ſome of the Iron uſed in fluxing it; it is therefore

therefore neceſſary to remelt it in an Iron ladle, when the Iron will immediately riſe at top, in form of ſcoria, when the Lead may be eaſily poured off, and the ſcoria will be left in the ladle. A little tallow may be added before the Lead is poured off, which will reduce ſome of the Lead that was burned, and increaſe the produce.

In this operation, the Iron having a ſtronger attraction to ſulphur than Lead, frees the Lead from it, which by this means is reduced to its metallick form. The Iron is alſo mineralized by the Lead, which is evident, by its melting the Mundick ſhine, which thoſe ſcoria exhibit when broke; but eſpecially by falling abroad when expoſed to the air, and being convertible into copperas, juſt in the ſame manner as the ſulphureous Marcaſites are.

If Lead Ores have arſenical pyrites mixed with them, the aſſay is more difficult; for in this caſe, they muſt be calcined like Copper Ores, and all the arſenick muſt be evaporated. By adding powdered charcoal in proportion to one quarter the weight of the Ore, it will expedite the calcination, and prevent it from running into lumps, which it is very apt to do.

When it is calcined, it muſt be mixed with its own weight, or more, of black flux, and about a quarter or fifth part of Iron filings; put on them a layer of ſalt, and melt down, till it flows thin; then pour it out, and treat the Lead as was done in the former proceſs, to free it from the Iron.

The uſe of the calcination in this laſt proceſs, is to diſcharge the arſenick, which renders the Iron eaſily fuſible; and if the Ore was not calcined, would fall down, in a reguline form, together with the Lead, and render it impure. Beſides, it would cauſe an imperfect ſeparation of the ſcoria, and keep up a great deal of the Lead amongſt them; for, as this arſenical regulus would incorporate with the Lead, the mixture would be much lighter than Lead. The Iron filings are added, to abſorb the vitriolick acid that may be left in the Ore after calcination.

Lead is aſſayed for Silver or Gold on the cuppel, as directed before; and all the Silver it contains above twelve troy ounces in the ton, is profit.

Proceſs

Procefs XVI. To affay Tin Ore, called Black-Tin.

The method of affaying Tin Ore is very eafy ; for in its form and fize of Black-Tin (which is the Ore dreffed by ftamping, feveral wafhings, and calcination, if mineralized with vitriolick, arfenical, or fulphureous pyrites) great part of the work is done to the affayer's hand ; fo that little more remains, than to proceed to immediate fufion, which is prefently accomplifhed by a red heat, in the following procefs.

Take four or five ounces of Black-Tin as emptied from the facks ; mix it well with about one-fifth part of its weight of powdered culm ; put the mixture in a Black-Lead crucible on the wind furnace, and in twenty minutes (more or lefs, according to the ftrength of the fire, and the greater or lefs fufibility of the Ore) you will find the Metal precipitated as far as may be to the bottom of the crucible, the culm and fcoria floating on the Tin, not in a vitrified, but loofe unconnected ftate. You will generally fee globules of Tin lying on the furface of this matter ; you fhould therefore with an Iron rod ftir the mixture, by which means moft of thofe globules will fall through it into the Tin at the bottom. Clofe the furnace, and let the whole remain in fufion from three to five minutes. Keep by you an Iron or Brafs mortar, and an ingot mould of about fix inches in length, fig. R, plate VI. Pour the Tin into the ingot, and empty the culm and fcoria into the mortar, fcraping off what remains in and about the crucible (which fhould always be of the Black-Lead kind) with a fharp iron. As foon as cold, put them into another mortar and pulverize them, firft in a fmall degree, fo as to feparate the fcoria from the largeft of the globules of Tin, fome of which will always remain therein after pouring out the ingot as before directed. Select the larger globules, and pulverize the remainder a fecond time ; then put this ftuff fo twice powdered on a fhovel, and paffing it often through water, in the fame manner as the lighter parts are wafhed from Ore in vanning, you will have the fmaller globules remaining on the fhovel ; and thefe with the larger (both together generally called Pillion-Tin) being added to, and weighed with the ingot, fhew the produce in Metal of the four or five ounces affayed.

Procefs XVII. To affay Cobalt.

Take a bit of the Mineral ſuppoſed to be Cobalt, with its weight of borax; put both into a broken china cup, and blow on them with a blow-pipe till they are perfectly melted and vitrified. If the china-ware is tinged blue in the ſpot where the Ore was placed, it contains Cobalt. But as ſome Ores contain Cobalt and Mundick together, in which caſe the Iron would render the Glaſs black, the beſt way is regularly to aſſay the Ore which is ſuppoſed to contain Cobalt, as follows:

Calcine an ounce of the Ore in the ſame manner as Copper Ore is directed to be calcined, only the calcination need not be carried ſo far; for as ſoon as the ſulphureous flame evidently diſappears, it is ſufficiently calcined. Melt the calx with black flux, as directed in the ſcorification of Copper Ore. Pour it out in the ingot, and melt a little of the regule with five or ſix times its weight of flint glaſs, and a little borax, for half an hour in a ſmall crucible. If the glaſs is of a fine blue colour, the regulus is pure; but if the glaſs is black, it contains Iron, and muſt be refined with the white flux, in the ſame way as is directed in refining the Copper aſſay. As long as the ſcoria are black or brown, the regule contains Iron; but as ſoon as the ſcoria, and ſides of the crucible, are tinged blue, it is fine: and if this does not happen, when the whole of the regule is conſumed, the Mineral contained no Cobalt. The goodneſs and value of the Mineral is eſtimated by the quantity of pure regulus it contained. If there is any Silver or Biſmuth mixed with the Cobalt, they will neither of them mix with the cobaltine regulus; but, on breaking the pot, will be found quite diſtinct from it: and it is the ſame if the matter is poured into an ingot.

This regulus is not to be made malleable, but from this proceſs is evidently that which ſtrikes the colour: for a further proof, take two ounces of ſmalt or powder blue, mix it with its weight of argol or tartar, and it will depoſit in fuſion the regulus that gave the colour. May it not be fairly concluded from hence, that all the Semi-metals which ſtrike any colour, will depoſit a regulus which is the efficient cauſe of it? But the knowledge of this valuable branch of Mineralogy is yet in its infancy with us.

Proceſs XVIII. To aſſay Biſmuth.

Biſmuth

Bifmuth is eafily feparable from its Ore, and may be procured pure by melting the Ore in a crucible in a moderate fire, without any flux; but if it is very impure, an addition of the black flux will foon fufe it: however, the fire muft not be too fierce, for if it be, the Bifmuth will be loft.

To difcover Silver in Goffans or very poor Ores.

Any Goffans or very poor Ores which are fuppofed to contain Silver, being calcined and mixed with three times their weight of litharge, may be affayed as directed in the procefs for affaying Mundick; only there will be no need of Glafs, as the Ores are fuppofed to be ftony. Care muft be taken, that the fcoria are thin at the laft, either by the continuance of the fire (by which litharge will be formed from the Lead at bottom) or by the addition of litharge, as directed in the aforefaid procefs. The china-ware crucible is alfo beft here.

CHAP. II.

Of Smelting of Copper Ores in the great Furnaces called Copper Works.

TO form a juft and general idea of the conftruction of furnaces, and of the difpofition of the feveral apertures in them, with a view to increafe or diminifh the activity of the fire, it will be proper to lay down, as our ground-work, certain principles of natural philofophy founded on experience.

Firft, Every one knows that combuftible matters will not burn or confume unlefs they have a free communication with the air, infomuch that if they be deprived thereof, even when burning moft rapidly, they will be extinguifhed at once; that, confequently, combuftion is greatly promoted by the frequent acceffion of frefh air; and that a ftream of air, directed fo as to pafs with impetuofity through burning fuel, excites the fire to the greateft poffible activity.

Secondly, It is certain that the air which touches or comes near ignited bodies, is heated, rarefied, and rendered lighter than

than the air about it, that is further diſtant from the center of the heat, and conſequently that this air ſo heated and become lighter, is neceſſarily determined thereby to aſcend in order to make room for that which is leſs heated and not ſo light, which by its weight and elaſticity tends to occupy the place quitted by the other: another conſequence hereof is, that if fire be kindled in a place encloſed every where but above and below, a current of air will be formed in that place, running in a direction from the bottom to the top; ſo that if any light bodies be applied to the opening below, they will be carried up towards the fire; but, on the contrary, if they be held at the opening above, they will be impelled by a force which will drive them up, and carry them away from the fire.

Laſtly, It is a demonſtrated truth in hydraulicks, that the velocity of a given quantity of any fluid determined to flow in any direction whatever, is ſo much the greater the narrower the channel is to which that fluid is confined, and conſequently that the velocity of a fluid will be increaſed by making it run from a wider through a narrower paſſage. Theſe principles being eſtabliſhed, it is eaſy to apply them to the conſtruction of furnaces.

The materials fitteſt for building furnaces are, bricks joined together with potter's clay mixed with ſand, and moiſtened with water; potter's clay mixed with potſherds, moiſtened with water, and baked in a violent fire: alſo Stourbridge clay, and many of our talcy clays to be had in great plenty in the Corniſh ſoft grouan ſtrata, mixed and baked in the ſame manner.

The only kind of furnace for ſmelting Ores where bellows are not employed, is what is called a Reverberatory Furnace. The Germans call it a Wind Furnace. It is alſo diſtinguiſhed by the name of Engliſh Furnace, becauſe the invention of it is attributed to an Engliſh phyſician. The Copper furnaces bear four names, viz. the Calciner, which is the largeſt; the Operation, Roaſter, and Refiner, which are all of one gauge or nearly ſo both in ſhape and ſize.

The hearth or bed of the calciner ſhould be eighteen feet long and thirteen feet wide within, by two feet ten inches at a medium from its concave back to the bottom, which muſt be flat. The fire place three feet four inches long, by two feet wide and two feet deep, ſo as to have two feet of flame to paſs over

over the Ore in calcination. The length and breadth of the mafonry of this furnace fhould be in proportion from out to out as they exprefs it, viz. twenty-four feet long, by eighteen wide.

Fig. 14, plate VI, reprefents a longitudinal fection of a reverberatory furnace ufed in the fmelting of Copper Ores: 1. the mafonry; 2. the afh-hole; 3. a channel for the evaporation of the moifture; 4. the grate; 5. the fire place; 6. the inner part of the furnace; 7. a bafon formed of fand; 8. the cavity where the melted Metal is; (that is, in the refinery, becaufe the Metal there is not tapped but laded out by an Iron ladle, therefore the bottom is concave, but thofe of the operation and roafter are flat) 9. a hole through which the fcoria are to be raked or removed; 10. the paffage for the flame and fmoke, or the lower part of the chimney which is to be carried up to a height of about thirty feet; 11. a hole in the roof, arch, or crown of the furnace, where the Ore is put in—This furnace is eighteen feet long, comprehending all the mafonry; twelve feet broad, and nine and a half feet high—The hearth or bottom is raifed three feet above the level of the foundery: on one fide is the fire place, under which is an afh-hole hollowed in the earth; on the other fide is a bafon made, which is kept covered with fire when there is occafion: on the anterior fide of this furnace there is a chimney, which receives the flame after it has paffed over the Ore that is laid upon the hearth. This hearth, which is in the interior part of the furnace, is made of a clay capable of fuftaining the fire. This furnace has a hole in its front through which the fcoria are drawn out; and a bafon, as we have faid, on one fide, made with fand, in which are oblong traces for the reception of the regulus, matt, or black Copper, when the furnace is tapped.

The infide of this furnace is commonly an elliptick curve; becaufe it is demonftrated by mathematicians, that furfaces having that curvature reflect the rays of the fun, or of fire, in fuch a manner, that, meeting in a point or line, they produce there a violent heat. The moft advantageous fize of the melting area of this furnace is feven feet ten inches long, four feet eight inches broad, and two feet high at a medium. The fire place two feet eight inches long, by two feet wide, fo as to form one foot nine inches fire: the refining furnace has alfo two fide doors, one for raking or fkimming, the other for lading.

Fig. 15, plate VI. reprefents the upper plan of the furnace of which fig. 14 is a fection: 1. the outer wall; 2. the draught-hole communicating with the afh-hole; 3. the door through which foffil coal is thrown into the fire place; 4. the place where an opening is made to let the melted Metal flow out of the furnace; 5. an opening through which the fcoria are raked and drawn off; 6. the bafon made of fand where the Metal lies; 7. the fire place with an Iron grate; 8. a fmall partition one brick thick between the fire place and the area of the furnace, over which the flame paffes—This is called the Bridge.

Copper is generally mineralized, not only by fulphur and arfenick, but alfo by Semi-metals and pyritous matters, and is frequently mixed with other Metals. As this Metal has great affinity with fulphur and arfenick, it is almoft impoffible to difengage it from them entirely by roafting: hence in the fmelting in great, nothing is obtained by the firft operation but an impure Copper, which contains all the principles of the Ore, excepting the earthy and ftony parts, particularly when the Ore is fmelted crude and unroafted. However, the Copper Ore when brought to the works in fome few places is refined by repeated fmeltings and roaftings without calcination: but as I propofe to defcribe all the proceffes for its ultimate refinery, I fhall begin with that of calcination, which in moft places is nearly thus.

A certain quantity of the Ores, called a charge, from ten, to thirty, or forty hundred weight, is put into the calciner, where it is frequently ftirred in fuch a heat as will not melt it, during a tide or twelve hours, more or lefs as the nature or mixture of the Ores require: two, three, four, or five hundred weight of this Ore is then put with five, four, three, or two hundred weight of raw Ore into an operation furnace. The fire is made very intenfe, and the whole becoming fluid and thin at the end of four hours the flag is fkimmed or drawn off through the hole of the furnace no. 5, fig. 15, plate VI, by an Iron rake called a Rabble. Another like quantity of Ore is put in, and the fame manœuvres being thrice repeated, the greater part of the remainder, being thus fkimmed, in a ftate of fluidity, and under a great heat, is at the end of twelve hours let out by a tap-hole in the fide of the furnace no. 4, fig. 15, plate VI, into a bed of fand where it forms itfelf into pegs or pigs, and is now a regulus. Thefe pegs are taken before they are cold, and on Iron wheel barrows are conveyed and plunged into a trough or ciftern of cold water. From thence the regulus is carried to a horfe mill, and there reduced almoft to a powder. In fome places this is done by women, girls, and boys, for the fake of employing them, which they term bucking the regulus, and is performed the fame as bucking defcribed in our chapter upon dreffing Copper Ores. In this condition it is carried to a furnace, called a Metal Calciner, where a quantity from fifteen to forty hundred weight (according to the capacity of the furnace) is fpread over the bottom, and, by fuch a fire as will not juft melt it, again calcined for about two tides or twenty-four hours. From thence it is drawn out, cooled by water, and carried to the Metal furnace, where it is fufed, fkimmed, and tapped out at the end of twelve hours in pegs, much in the manner of the operation furnace before defcribed. The roafting furnace next takes this Metal (as the workmen call it, though it is very far from being in a ftate of malleability) whole in the pegs, where they are roafted fixteen or eighteen hours, and when the fire is rifen, they are melted, fkimmed, and tapped as before. This operation of roafting and flowing, &c. is repeated three or four times; fome Copper Metal evidently appearing in it, it is carried to the coarfe refining furnace, from whence when melted, fkimmed, and ready for its exit, it is not tapped, but taken out in Iron ladles and thrown into oblong Iron pots or moulds by a ladle full at a time, each mould containing about one hundred and a half. A quantity of this fine Copper from fixteen to twenty-five hundred weight according to the capacity of the furnace and ufage of the works, is put into the refiner, or refining furnace, where being again melted by an intenfe heat, fkimmed, and otherwife rendered proper for the purpofe, it is again laded out in fuch fhapes and quantities, as the mafter or director of the works requires, and may beft fuit the rolling mill, the battery mill, or the other demands of the manufacturers.

I fhall make no mention of extracting the fmall quantities of Copper and heterogeneous Metals which remain in the flags or fcoria fkimmed off in the feveral operations, which after extraction is often mixed with fome others to make thofe inferior Metals called Pot-metal, Manillions, &c. nor of the feveral kinds of fluxes which are few and differently ufed by different operators, neither can it be of fervice to any but an adept in the bufinefs. My intention is only to give a general idea of the proceffes in fmelting as far as they have fallen under my obfervation, and not meddle with the private manufactory or œconomical

mical applications of thofe objects of trade and commerce. The reader may obferve how much more tedious, difficult, and expenfive the refinery of Copper is, compared to that of Tin, and therefore may be lefs furprifed at the difference which fometimes happens to be between the buying price of Ores, and the felling price of Copper. That we may illuftrate the labour, expence, and complicated calcinations, roaftings, fmeltings, and meltings, for the refinery of Copper, which do not amount to lefs than twelve or fourteen operations, we fubjoin an eftimate of the confumption of coal in working one hundred tons of Copper Ore.

	Weys	Ch.	Bufh.
To calcining fifty tons of Ore, one chaldron of coal to four tons — — — —	6	0	18
To reduce ditto with fifty tons of raw Ore to a regulus, each two tons of Ore requiring one chaldron of coal — — — —	25	0	0
To calcining forty-two tons of ditto, each ton holding thirty parts of Copper in one hundred of regulus, one chaldron of coal to two tons of Ore — — — — —	10	1	0
To melting thirty-eight tons of ditto, the other four being evaporated in the calcination — — — — — — —	9	1	0
To bring forward in the roafters fifteen tons, thirteen hundred of Metal from the regule, holding eighty parts of fine Copper in one hundred, divided into ten loads, each requiring three roaftings to bring it to coarfe Copper, each roafting confuming eighteen bufhels of coal — — — — —	7	1	0
To refining the fame, being twice laded —	6	1	0
To reduce the flags of the whole fuppofing them thirty tons — — — — —	7	1	0
	72	1	18

Thus

Thus we fee that the Copper of pyritous Ores cannot be obtained without feveral operations, which vary according to the nature of the Ores. Thefe operations are chiefly by roaftings and fufions; and by the interference of calcinations in fome portion of the fame Ores likewife. By the firft fufion a matt or regulus is produced, which is afterwards to be roafted; and thus the fufions and roaftings are to be alternately applied, till by the laft fufion Copper is obtained.

Thefe methods of treating pyritous Ores depend on the two following facts: 1. Sulphur is more difpofed to unite with Iron than with Copper. 2. The Iron of thefe Ores is deftructible by the burning fulphur during the roafting or fufion of the Ores, while the Copper is not injured. This fact appears from the daily practice of fmelting cupreous Ores highly impregnated with Mundick that is either fulphureous or arfenical.

From thefe facts we learn, that fulphur may be employed to feparate and deftroy Iron mixed with Copper; and that on the other hand, Iron, or Gal, or Goffany Ores, may be ufed to feparate the fulphur from Copper; fo that by adjufting the proportion of fulphureous-mundicky, arfenical-mundicky, and Goffany Copper Ores, to each other in the fmelting, thofe fubftances may be made to deftroy each other, and procure a feparation of the Copper, in which the greateft art and myftery of the fmelting bufinefs confifts. (Scheffer, Schlutter, Margraaf, Macquer.)

The firft Cornifh Copper Ores (in order I fuppofe to avoid having the procefs of fmelting divulged) were carried to Briftol. A palpable miftake was committed in this cafe, as it was neceffary to fuftain a double expence of carriage. This was, however, foon rectified; and moft of the different companies erected their Copper works in fome fpot of Wales, convenient for the carriage of the coals from a neighbouring colliery; and likewife with the advantages of a little harbour. It is a circumftance of fome importance, while we confider this affair, to obferve, that, as the numerous fire engines employ a large fleet of colliers to fupply their demands, fo the back carriage of the Ore is by no means fo confiderable as it would otherwife be. But let us turn our eyes to the flourifhing ftate of Swanfey, Neath, and thofe other parts of Wales, which have been fo very fortunate as to become the factories of the different Copper companies; and let us confider thofe populous towns as owing their exiſtence and wealth to our indolence and inattention. The evil hitherto has ſeemed irremediable to the ſpiritleſs inhabitants of our county, from the vaſt opulence of the different companies, whoſe intereſt it muſt be to ſupport the preſent ſyſtem, the channel of their wealth. They know, that it would require a greater purſe than any one or two private gentlemen are able to furniſh. It was however attempted, about ſeventy years ſince, by Mr. Scobell, at Polruddan in St. Auſtle, with whom Sir Talbot Clark and Mr. Vincent joined, where the firſt piece of Copper ever made ſo in this county, was ſmelted, refined, and brought to perfection. After this John Pollard, Eſq; of Redruth, and Mr. Thomas Worth, of St. Ives, made a ſecond trial; but both theſe attempts failed of ſucceſs, more through ill management, roguery of the workmen, and the improper ſituation of their works, than any extraordinary charge of the fuel. After theſe, one Gideon Coſier, of Piran Zabuloe, erected an houſe for the like purpoſe at Pen-pol in the pariſh of Phillack, but being ſoon taken off by a Fever, when he had made a fair progreſs in it, the ſame was carried on by Sir William Pendarves and Robert Corker, Eſq; who have both aſſured the writer (Thomas Tonkin, Eſq;) that they could ſmelt their Ore as cheap (all hazards conſidered) as the companies could pretend to do at their works in Wales. They did ſo accordingly for ſome years; but being ſince dead, and their affairs falling into ſuch hands as had other intereſts to mind, this project too ſunk with them. A ſmall beginning was alſo made to the ſame purpoſe at Lenobrey in St. Agnes, where they ſmelted ſome Copper with good ſucceſs; but were obliged to give it over for want of a ſufficient ſtock to go on with it.

From all theſe infant eſſays and ſome obſervations made and gathered from workmen abroad, but chiefly from the late Mr. Coſter, largely concerned in the White Rock Works at Swanſey, who owned to Mr. T. that moſt of our Ores might be ſmelted nearly as cheap here as abroad; I am convinced (if we allow for the great ſalaries the ſaid companies are obliged to give to their agents here and elſewhere; the hazard of Ore on ſhipboard in time of war, and double freight to paſs and repaſs our own inhoſpitable coaſt, with the riſk of being caſt on their native ſhore) nay, I believe it would amount to a demonſtration, that it might be done much cheaper and more advantageouſly in ſome convenient places in this county than in Wales. Notwithſtanding this, it has been the refinement of Corniſh policy to ſuffer the exportation of their raw ftaple, in order to give other countries the benefit of its manufacture !

To remedy this intolerable grievance, a propofal was made to fome of the principal gentlemen of the county, to join in a petition to her Majefty Queen ANNE (and had not her fudden death prevented it, it might have been effected) that her Majefty would be pleafed to lay it before her parliament, to have our Copper Mines fubject to the ftannary laws in all things (except being under bounds) and have the Copper coined at the neighbouring coinage towns, as the Tin is, under a duty of one fhilling ℘ hundred of fine Copper to be paid to the Duke of Cornwall ; which, as it would be an addition to the ducal revenue, and managed without any furcharge by the fame coinage officers, fo would it effectually fecure the fmelting and refining all the Copper Ores within the county, by degrees let us into the true value of our commodity, and the management of it, as eafy as that of Tin ; and furthermore confine the labour and profits in the manufactory thereof among ourfelves. This fmall memorial of the above defign, Mr. T. fays, he has left behind him to be digefted in better order by wifer heads, whenever they fee convenient feafon to put it in execution. (Anonym. Addrefs, Tonkins MSS.)

Thus far had been attempted the fmelting of Copper Ore in Cornwall, which it muft be owned had been fruftrated through the confederacy of oppofite interefted companies, and the want of fufficient infight into the art of fufion more than from the attributed extraordinary expence of fuel ; till about the year 1754, when one Sampfon Swaine, in conjunction with fome gentlemen of Camborne, erected furnaces at Entral in that parifh ; but their fituation being too remote from coal, they removed their works to Hayle. The author very well remembers the combinations which were formed to overthrow this laudable effort. The companies left no method unfought to traduce the credit, and ftab the vitals of this undertaking. Threats and remonftrances were equally ufed to oblige or cajole the owners of the Mines to abandon or fupprefs the new company at Hayle. The opponents of this affociation ufing every expedient to mortify the fpirit of this arduous undertaking, alternately raifed the price of Copper Ores, and lowered the value of fine Copper, to the great lofs of the contending parties ; which will ever be the cafe where monopolies are difturbed, and the almighty power of opulence can prevail. But happening to have

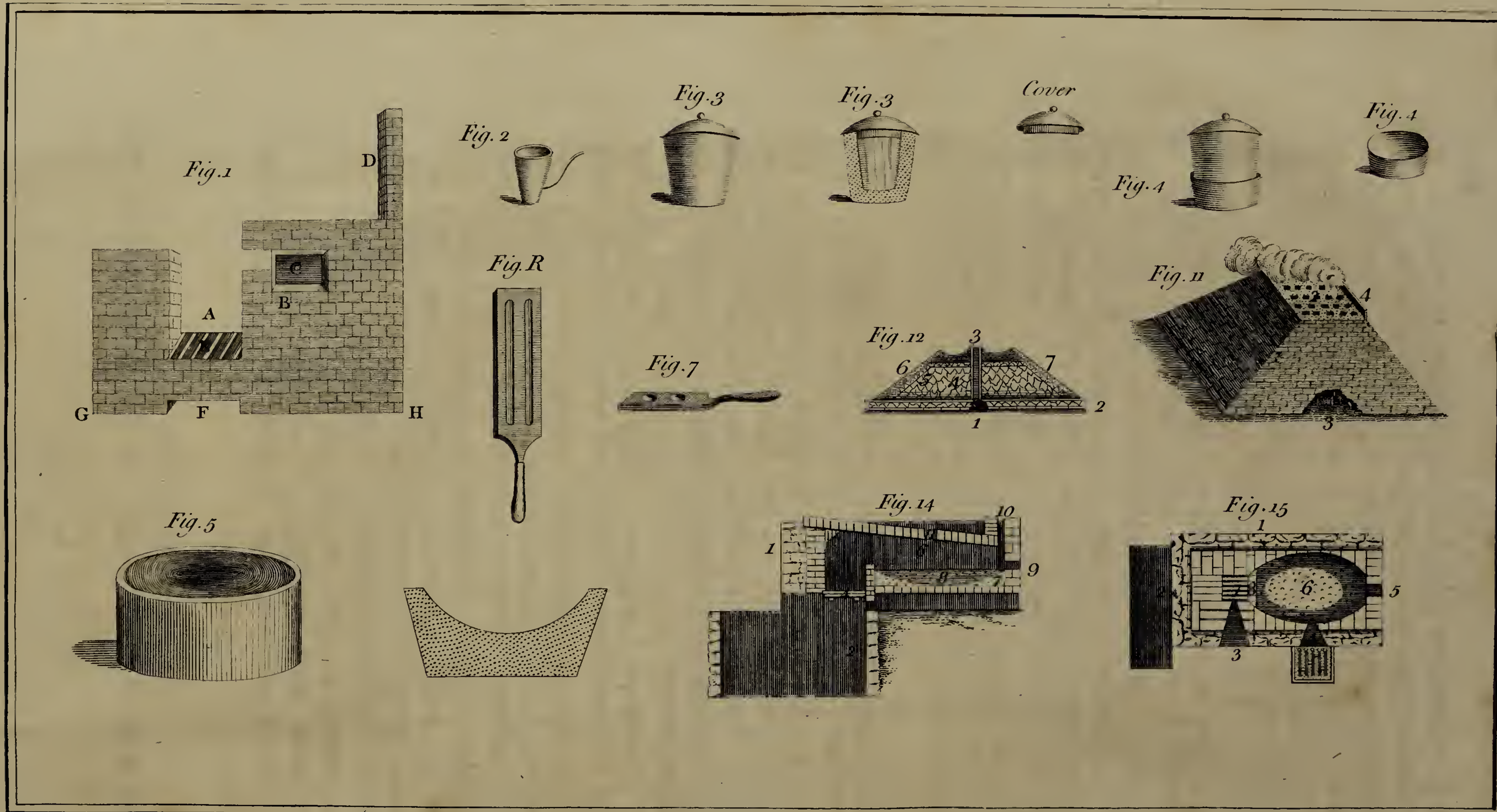
have men of fortune and capacity at their head, they were founded in prudence, and withftood the fhocks of power and artifice.

That it will anfwer to fmelt Copper Ores on this fide the channel, is undeniably demonftrable by the thriving fituation of this Cornifh Copper Company, who would not fo vaftly increafe the number of their furnaces without having experienced the benefit of their undertaking.

Similar to that, another company erected works at North-Downs in Redruth a few years back. Perhaps their fmall beginning did not excite the notice of the other companies: however, their induftry and œconomy have been fuccefsful; and after having enlarged their works in that unfit place, at a great expence, they have now removed the fame to Tregew, on a branch of Falmouth harbour, for the more profitable conducting the concern. I have further to add, from the beft authority, that they are thriving under this removal and many other difadvantages. It is much to be wifhed, that fome fpirited gentlemen would imitate their example; and as fuch a ftep would be of great advantage to themfelves and the community, I will fuppofe they will, e'er long, fee with their own eyes and judge for themfelves.

In this little hiftory of fmelting Copper, no notice hath been taken of thofe who attempted the practice of boiling and roafting at the fame fire. In fact, nothing could profper in fuch hands. Neither can we commend the temerity and improvidency of thofe who built their furnaces like churches, upon the fame plan; not well confidering, that a heat for the fufion of ftubborn Ores, can fcarcely be too focal or concentrated.

CHAP.



To Sir Frederick Lemon Rogers, of BLACHFORD in Devonshire, Baronet.
This Plate engraved at his expence, is most gratefully Inscribed, by
W.^m Pryce.

C H A P. III.

Of Smelting Tin Ore, or Black Tin, in the great Furnaces at the Smelting-Houfe.

AS Tin was the fole metallick produce of the earlier ages, fo it is more than probable the raw Mineral was never exported. It would be hard to fuppofe the Phenicians, who carried the arts to fo great perfection, would be at the pains of tranfporting the ufelefs fcoria to fo great a diftance; efpecially, when the woods, with which the country in thofe days was over-run, afforded fo eafy a method of reducing it by fufion into a fmaller compafs. Some late difcoveries, where the char-coal and drofs of the Metal have been found mixed together, have given us an idea of their procefs, which was to dig a hole in the ground, and throw the Tin Ore on a charcoal fire, which probably was excited by a bellows. Agreeably to the fimplicity of the times, no notion was entertained of confining the fire, to make it act more forcibly on the fubftance to be fmelted; no furnace either fimple or reverberatory had ever been made ufe of. The natural confequences of this were an undue confump-tion of fuel, and a great lofs in the produce of the Ores; as the more ftubborn parts would not give way to that degree of heat, which by this method they were able to apply to them.

The little intercourfe that fubfifted in former times between this county and its oppofite fhore, has been attended with a fatal and lafting inconvenience: I mean the devaftation of its woods. Nature feems to have difcovered her reluctance in depriving herfelf of the ornament and protection her woods afford her, by fubftituting a foffil which poffeffes all the advantages of a cheap and durable fire. Though this fubterraneous fuel hath not yet been, nor perhaps ever will be difcovered to be a native of Cornwall, yet fuch is its portablenefs, that we are enabled to procure it from Wales, at a cheaper rate than common fire wood, including the expences of felling and carriage. So long, indeed, as an undue quantity of wood land rendered its con-fumption neceffary for the purpofe of purifying the air, and to make room for more ufeful productions (and fuch undoubtedly was the fituation of this county on the firft difcovery of Britain) fo long was it a practice highly commendable to employ the ſuper abundant fuel to ſo beneficial a purpoſe. But when we behold a wide and barren waſte, extending itſelf throughout the whole Mining diſtrict of this county, without a tree to intercept the fury of the wind, we have no reaſon to commend the prudence of our anceſtors, in thus depriving their demeſne of its neceſſary ſhelter.

It is ſtill a pleaſing reflection to conſider, that one of the moſt eſſential maxims of ſtate has been conſtantly adhered to, I mean that of manufacturing their Tin at home. The practice at firſt was obvious: the wood probably grew on the margin of the ſhaft from whence the Ore was raiſed, and it muſt have been neceſſary to clear large ſpots of it, to give the Miner room to place his Tin-ſtuff and erect his engines. The great demand for this article which no known part of the world at that time produced, occaſioned a ſcarcity of fuel to be very early felt, and the heavy expence of fetching wood from diſtant parts naturally enhanced the price of Tin. The diſcovery, or, rather, the introduction of ſea coal, made a great alteration in the Mining ſyſtem: this valuable ſubſtitute came into general uſe, and put a ſtop to that ravage of coppice which was travelling inſenſibly to the eaſtward; and though the obſervation may be new, yet it appears clearly to me, that we ſtand indebted to our neighbours the Welch for even the ſmall quantity of wood land that ſtill remains in the eaſtern part of the country.

Neceſſity at laſt ſuggeſted the introduction of pit-coal for the ſmelting of Tin Ore; and among others, to Sir Bevil Granville, of Stow, in this county. Temp. Car. I. who made ſeveral experiments, though without ſucceſs: neither did the effectual ſmelting of Tin Ore with pit-coal take place, till the ſecond year of queen Anne, when a Mr. Liddell, with whom Mr. Moult, a noted Chymiſt, was concerned, obtained her Majeſty's patent for ſmelting Black Tin with foſſil-coal in Iron furnaces. The invention of reverberatory furnaces built with brick, ſtone, ſand, lime, and clay, ſoon followed this diſcovery; the form of which, being ſimple, has admitted little improvement to the preſent time.

The Tin ſmelting furnace differs little from that made uſe of for ſmelting Copper, only it is not quite ſo deep, as it is tapped at every charge. The charge for one of theſe furnaces is from five to ſix hundred weight of Black Tin, well mixed with a tenth or a twelfth its weight of culm. This furnace is charged through a hole a hole in the ſide (directly oppoſite to the tap-hole) through which it is thrown into the furnace with a ſhovel, and levelled over the bottom with an Iron rake or paddle from the mouth. This done the apertures are immediately cloſed, and the fire raiſed to a very great ſtrength, in which ſtate it is left between four and five hours, when the door is taken off, and the whole charge is well ſtirred together. The foreman of the work at this time examines the ſtate of the Metal, &c. and if he thinks it convenient, orders an additional quantity of culm, at his diſcretion, to be put into the furnace, which is cloſed again and left in this condition, the fire all the time being kept fully up, till the end of about ſix hours from its receiving the charge; at which time it is again examined by the foreman, and, if he finds it proper, is then tapped, and the Metal let out into a fixed baſon made of clay, and of a capacity to hold ſomething more than the Metal of the charge: as in ſome ſorts of Tin the ſcoria being vitrified to a conſiderable degree, part thereof will flow out with the Metal; but this is not commonly the caſe in any large quantity. The ſcoria remaining in the bottom of the furnace is raked out at the mouth, and falls into a ſmall pit under it made for the purpoſe, and has generally adheſion enough to form into a cake. As ſoon as it is cold, it is carried to the ſtamping mill in order to ſeparate the globules of melted Tin diſſeminated through the ſcoria or ſlag. The ſcoria being broke by hammers to the ſize of gooſe eggs, are put into the firſt ſtamping mill, and paſſed through ſmall Iron bars, (inſtead of a holed Iron plate) none paſſing through thoſe bars above the ſize of a horſe bean. By this means the pillion (for ſo all Tin recovered out of the ſlags is called) of the larger ſize is taken out, and thereby prevented from waſte by too much ſtamping. The refuſe of this firſt ſtamping is put into other ſtamping mills of a ſecond, a third, and even ſome part thereof into thoſe of a fourth ſize. The pillion in the firſt and ſecond of the ſtampings is ſeparated from the ſcoria in the ſame manner as Copper Ore from its waſte, and that of the ſlimes of theſe, together with the third and fourth ſtamping, in the ſame method as Tin Ore at the ſtamping mills. Of the pillion ſo ſeparated, all the rough or grainy parts are conſidered as Metal, and refined accordingly by being ſmelted without any flux, and the produce of this ſmelting refined with the Tin firſt tapped. The ſandy and ſlimy parts of the pillion reſembling ſtamped Tin Ores, are treated as ſuch, and are mixed and ſmelted with them.

I now

I now return to the Tin in the bafon, or float, as it is called; which, as foon as it is come down to a moderate heat, is laded out into the moulds, in flabs or pigs, of about three quarters of an hundred weight; not larger, becaufe they would be too unweildy to heave into the furnace for refining, to which I now proceed.

The furnace having, by the fide of the fmall float juft now defcribed, a larger one capable of holding twenty or more blocks, is for this purpofe fuffered to cool to a certain degree, and then charged full with the flobs juft mentioned, the tap-hole being kept open, fo that as the Tin melts in this moderate fire, it makes its exit through it into the float, where while running out it is frequently ftirred and toffed by a ladleful at a time held arm high, letting it fall in a ftream into the mafs of Metal, when the fcum which arifes is taken off. While the Metal already put into the furnace is melting, more is added, fo as to be juft enough to fill the float with good Tin: and this after being toffed and fkimmed as before, and fuffered to cool to a proper temper, is carried in Iron ladles to moulds holding generally fomewhat above three hundred weight, (then denominated Block-Tin) where they are marked as the fmelters choofe, with their houfe mark, which may be a pelican, a plume of feathers, a ftag, or a horfe, by laying Brafs or Iron ftamps on the face of the blocks while the Tin is in a fluid ftate, yet cool enough to fuftain the ftamping iron. The blocks are then ready to be weighed, numbered, and fent to the neareft coinage town to be coined.

There yet remains in the furnace the droffy part with which the Tin was contaminated, and which, not melting with the flow fire made ufe of, holds with it a confiderable portion of good Tin. The fire is, therefore, now encreafed, fo as to melt the whole; which is then tapped out altogether into the fmall float, where the Tin fubfiding, and the drofs rifing to the top, the latter, foon cooling, is taken off and fet by, and the Tin laded into fmall flabs as at firft to be again refined. The furnace is now charged again as before; and after cleanfing again, generally employed to fmelt Tin Ore as ufual. The Tin that remains in and about the fcoria and drofs of the laft tappings, &c. is recovered by repeated fmeltings, till at laft being almoft entirely drained of that Metal, they become what the workmen generally call Hard-heads, confifting of fuch heterogeneous Metals

Metals as were included in the firft mixture, and efteemed of no further value.

The qualifications of a good Tin fmelter are a thorough knowledge of the different kinds of Tin Ore, and of the nature and principles of the different Metals and Minerals mixed therewith; as on this knowledge, not only the making good Metal, but alfo getting the full produce of the Ore, muft entirely depend; and for the want thereof, nothing, not even great care and long experience, can compenfate. It is to the want of this infight in the fmelting bufinefs, or at leaft to an inattention thereto, that we are to afcribe the great quantity of bad Tin which is paffed the coinage every quarter; much to the fhame of the Tin fmelters, and ftill more to the reproach of Stannary government, for fuffering a place of great truft and profit to become a finecure to fome mercenary borough man! Yea, even worfe, a cloak for ill proceedings. Were thefe matters properly attended to, and the duty of the affay-mafter ftrictly enforced, it would operate more towards preventing foreign importations of Tin into Europe, and extending the fale of our own, than any, or all other regulations that can be made refpecting the Tin trade!

Four fupervifors of the Tin in Cornwall and Devon, were firft appointed by king Charles the fecond. Their office is to infpect the blowing and fmelting houfes, to fee that no cheat or fraud be committed in the blowing or fmelting of Tin, and for fundry other beneficial purpofes relative to the common-weal of the Stannaries. But of all offices belonging to the Tin, this, though inftituted on a very good principle, is now the leaft regarded. If the fupervifors, who now receive each of them eighty pounds ℘ annum for doing nothing, were obliged to vifit thefe houfes twice a week, their trouble would not be great, and their diligence might anfwer the end, and make their places ferviceable to their country. (Anon. Addrefs; Tonkins MSS.)

CHAP. IV.

Of the Sale of Copper Ores; and of Black Tin at the Smelting-Houfe, and after it is fmelted and coined in Blocks.

THOUGH the richnefs of our Copper works is not a late difcovery; yet it is not a hundred years that the knowledge of working them to good effect hath been underftood. The moft obvious reafon is, that it was the intereft of the firft difcoverers to keep the natives in profound ignorance. Mr. Carew, in the reign of Elizabeth, hints at the little profits made in Cornwall from Copper: "It is found," fays he, "in "fundry places, but to what gain to the fearchers I have not "been curious to enquire, nor they hafty to reveal: for of one "Mine, of which I took view, the Ore was fhipped to be "refined in Wales, either to fave coft in the fuel, or to con- "ceal the profit." Mr. Norden, one hundred and feventy years fince, feems to have had full information that the Cornifh Copper Mines were rich, and, therefore, in his letter to king James the firft (fee his Surv. of Cornwall) like a faithful fervant, intimates the expediency of a better infpection into the ftate of thofe Mines, and furmifes the arts by which the value of them was concealed: "So rich are the works," fays he, "efpecially "fome lately found, as by the opinion of the fkilful in the "myftery, the like have not been elfewhere found, though the "worth hath been formerly extenuated by private pryers into "the fecret, and covertly followed for their own gain." Notwithftanding thefe hints, we do not find any thing material going on here as to the improvement of the Copper Mines, till, about eighty years fince, fome gentlemen of Briftol made it their bufinefs to infpect our Mines more narrowly, and bought the Copper Ores for two pounds ten fhillings to four pounds ℘ ton. The gains were anfwerable to their fagacity and diligence, and fo great, that they could not long be kept fecret, which encouraged other gentlemen of Briftol about fixty years fince to covenant with fome of the principal Miners in Cornwall to buy all their Copper Ores for a term of years at a ftated low price, particularly with Mr. Beauchamp, the grandfather of the prefent John Beauchamp, Efq; to buy all the Copper Ore which fhould rife out of a Mine well ftocked, for twenty years, at five pounds ℘ ton;

℘ ton; and the Ore at Reliftian in Gwinear was covenanted for at two pounds ten fhillings ℘ ton.

About fifty years back great quantities of Copper Ore were rifen from three principal Mines in this county; viz. Huel-Fortune in Ludgvan, Rofkear in Camborne, and Pool-Adit in Illugan; the produce of which Mines were fold to the few buyers at their own price. The four Copper Companies, viz. the Brafs-Wire Company, the Englifh Copper Company, Wayn and Company, and Chambers and Company, being then united and confederated, there can be no doubt of their beholding with a fingle eye their joint intereft and purfuit; till they were interrupted by a gentleman from Wales, who vifited this county in order to improve his own branch of bufinefs in the fame way. Let his motives be ever fo felfifh, the gentlemen Miners at that time, if not their pofterity, were manifeftly benefited by his vifit; for juft then, fourteen hundred tons of Copper Ore, which had been lying unfold fome years at Rofkear and Huel-Kitty, were offered to this gentleman, and for which the confederated buyers would give only four pounds five fhillings ℘ ton. But fo contracted were the principles of the Miners in thofe days of unremediable oppreffion, that they obliged this friend to their country to depofit a fum of money equivalent to the fuppofed amount of their Ores before they would confent to weigh them off at the advanced price they had agreed to take for their commodity. Thefe confined notions will ever prevail where the trade of a country is fubject to the domination of rapacious and difhoneft combinations. However, this gentleman bought the fourteen hundred tons of Ore at the advanced price of fix pounds five fhillings ℘ ton, which he paid for with ready money, and gained much above thirty ℘ cent. as the writer is well informed from the moft indubitable authority! What muft have been the profits of companies confederated to ferve their own interefts without limitation or controul? This new comer bought nine hundred tons more at Rofkear at feven pounds ℘ ton; and in lefs than fix months before he left Cornwall he purchafed three thoufand tons, upon which he defervedly made, very little, if at all, fhort of forty ℘ cent. profit.

Soon after this, the buyers and fellers mutually agreed to ticket for all Copper Ores which fhould be ready for fale at ftated times, and the higheft bidder or ticket fhould be the purchafer. On the very onfet of this compact, three hundred tons of Ore belonging to the fame Mine were to be ticketed for on a day appointed

appointed, in Redruth, when the agent of the Mine having abſented himſelf ſome time beyond the limited hour of ſale, a certain gentleman of great addreſs, power, and fortune, declared himſelf the purchaſer by private contract at eight pounds ſeventeen ſhillings ⅌ ton, when one of the ticketers preſent produced his ticket before all the company, whoſe offer was nine pounds ſeventeen ſhillings ⅌ ton, to the ſhame and confuſion of all the adventurers.

It is to this nefarious tranſaction that we owe the preſent mode of ticketing for Copper Ores. The proprietors and adventurers in Mines of thoſe times, found themſelves in a predicament ſingularly ridiculous and diſtreſſing: they poſſeſſed a commodity whoſe value they could not tell how to aſcertain; and the buyers, who were acquainted with every requiſite for their own advantage, had formed themſelves into a confederacy the moſt pernicious and deſtructive to the whole Copper Mine intereſt of this county. It was impoſſible that ſuch a ſtate of affairs ſhould long continue. The ſecret at length tranſpiring, other companies were gradually formed; and from an oppoſition and rivalſhip in trade, the adventurer received a better price for his Copper Ore, though far beneath its juſt value.

In the beginning of my acquaintance with Mining affairs, about twenty-ſeven years paſt, there were ſix companies eſtabliſhed for buying of Copper Ores. At preſent I think there are thirteen companies, which attend by their agents, and throw in their tickets on the day of ſale. It will be neceſſary to premiſe that a day of ſampling is fixed (ſee book iv. chap. ii. p. 245) with a fortnight's interval between it and the ticketing day for trying the ſamples of Ore and receiving anſwers from their principals. On this ticketing day a dinner almoſt equal to a city feaſt is provided at the expence of the Mines, in proportion to the quantities of Ores each Mine has to ſell; and the adventurers, with the companies agents, aſſemble together. Soon after the cloth is removed, the tickets containing the different offers of the different companies are produced and regiſtered by the agents of both buyers and ſellers, the originals being delivered to the proprietors of the Mines; and the higheſt bidders are of courſe the buyers. In order to evidence the conciſe and eaſy method of ticketing for Copper Ores, I have jubjoined a duplicate of a ticketing paper, by which the reader may apprehend, at one glance, that ten thouſand pounds worth of Ores may be ſold and appropriated to the reſpective buyers in half an hour's time.

COPPER ORES Sampled the 26th of June 1777, and Sold the 10th of July 1777, at REDRUTH.

BUYERS NAMES

	Tons	Hore	Bevan	Phillips	Williams	Smith	Bennallack	Edwards	Ennis	Dickenfon	Stephens	Carkeet	Warren	Papps
		£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Roſkear — —	86	5 2 6	6 1 0	6 0 0	6 3 0	6 0 6	5 11 6	6 6 0	5 9 6	5 0 0	5 15 6	5 14 0	6 4 0	6 0 0
	*68	12 4 0	10 15 0	11 4 0	12 4 0	11 2 0	11 16 0	12 4 6	12 4 6	11 2 6	12 2 6	11 18 0	12 3 6	11 19 6
	54	9 17 6	8 14 0	9 0 0	9 16 0	8 19 0	9 13 6	9 11 0	8 18 6	9 1 0	9 1 6	9 3 0	9 14 0	9 3 6
	50	11 1 0	10 2 6	11 2 6	11 5 0	11 3 0	10 18 0	11 1 0	11 5 6	11 3 0	10 18 0	10 19 0	11 5 0	11 0 0
	42	7 3 0	7 4 0	6 16 6	7 2 6	7 1 6	6 19 6	7 2 0	7 3 6	6 17 0	6 19 6	6 16 6	6 19 0	6 15 0
	19	14 2 0	13 13 0	14 1 6	14 0 0	14 1 0	13 18 0	14 1 6	13 19 6	13 16 6	13 18 0	13 19 0	14 5 0	13 18 6
Huel-Gherry —	44	7 14 6	7 3 6	7 9 0	6 18 6	7 5 0	7 15 0	7 3 6	7 1 0	6 19 0	6 19 6	6 18 0	7 4 0	6 17 0
	32	3 2 6	4 1 0	3 10 0	3 15 0	3 2 6	3 3 0	3 19 0	3 16 6	3 4 0	3 11 6	3 5 6	3 19 6	3 15 0
	26	4 6 0	3 19 6	3 18 0	3 16 6	3 11 6	3 14 0	3 12 0	3 13 6	3 10 0	3 17 0	3 19 0	4 0 0	3 14 0
	9	2 2 0	1 18 0	1 15 0	1 16 0	1 19 0	1 15 0	2 2 6	1 16 0	1 14 0	1 19 0	1 13 0	1 19 6	1 17 0
Huel-Chance —	90	8 9 0	7 19 0	8 10 0	8 5 0	7 19 0	7 18 6	8 2 6	8 3 0	7 17 6	7 5 6	7 15 0	8 8 0	8 0 0
	84	6 4 0	5 18 0	6 6 0	6 11 0	5 15 0	5 17 6	6 5 6	6 4 0	5 10 0	5 12 6	5 15 6	6 4 6	6 1 6
	56	4 2 6	6 0 0	4 19 6	4 14 6	5 9 0	5 15 0	5 18 0	5 16 0	5 1 0	5 14 0	4 4 0	5 13 0	5 12 6
	44	18 1 0	17 2 6	17 17 0	18 2 0	16 19 0	16 19 6	17 17 6	17 9 6	17 0 0	16 19 0	16 16 0	17 9 6	17 14 0
	20	3 2 6	3 5 0	2 19 0	2 16 0	3 12 6	3 1 6	3 11 0	2 18 0	2 15 0	2 17 6	2 18 0	2 19 6	3 0 0
Ditto Halvan's Ore	20	1 19 6	2 2 0	2 1 0	1 18 6	1 16 0	1 15 0	2 2 6	2 0 0	1 16 0	2 3 0	1 15 0	1 17 0	1 19 0
Stampt Ore — —	15	1 10 0	1 14 0	1 15 0	1 11 0	1 14 6	0 0 0	1 16 0	0 0 0	0 0 0	1 11 6	0 0 0	0 0 0	0 0 0
Vivian's Burnt Ore	5	1 2 6	1 3 0	0 0 0	0 0 0	0 0 0	0 0 0	1 5 0	0 0 0	0 0 0	1 1 0	0 0 0	0 0 0	0 0 0
In all	764	80	130	90	128	20	44	149	84		20		19	

* This parcel to be equally divided between Edwards and Ennis, both offering £12 4 6.

By this method, which has fubfifted fince its firft eftablifhment to this time, fixteen thoufand pounds worth of Ore are monthly difpofed of in entire dependence upon the honour of the purchafer, and which I believe is not to be parallelled in any part of Great-Britain. Sed humanitas et gratior et tutior. Permit me, for argument's fake, to fuppofe thefe gentlemen acting on the moft honourable principle; yet ftill there is an unavoidable inconvenience, which may be of the moft deftructive confequence to the feller. What I mean is this: whenever a purchafer does not want a particular parcel of Ores, or perhaps does not mean to purchafe at all, it is ufual for the agent of that company to affix a price to his ticket much below his computed value of thofe Ores. On the fuppofition of non-communication between the buyers (which is the only foot on which the favourers of the prefent fyftem reft their caufe) it muft frequently happen, that all companies muft be in the fame predicament with refpect to fome parcels of Ores; the confequence is, thofe Ores go off at a low value, and become the property of perfons who did not mean to buy them. This is putting the cafe in the faireft light; and, to conceive the mifchief which follows, we are to obferve, that thofe parcels amount to very capital fums of money, and that the lofs fuftained by the proprietors is proportionably large.

I have mentioned, above, the emulation natural to rival companies; but it is to be feared that principle has long ceafed to operate: and as there is Copper Ore raifed in the county fufficient for them all, they do not wifh to pufh one another. On the contrary, the utmoft harmony feems to fubfift between them; and the talk of eftablifhing a new company is fure to be followed by an affociation of the old ones, in order to defeat it.

I know it has been urged, that large quantities of Copper Ores lie at the feveral furnaces unfmelted, that much Copper remains unfold, and thefe to the amount of a confiderable fum. Admitting this argument, let us for a moment confider the benefit of thefe pretenfions to the purchafer. He thereby pretends, that he is buying Copper which muft remain on his hands; and by way of allowing himfelf intereft for his money thus lying dead, he has the modefty to fink the raw commodity from twelve ℔ cent. which is a very handfome profit upon a merchandize unperifhable, to thirty, and more frequently to forty, ℔ cent. It is a great pity that the amazing monthly

 expence

expence of deep Mines, joined to the narrow circumſtances of many of thoſe concerned in them, ſhould make it neceſſary for thoſe Mines to ſell their Ores immediately for the price they can get; as the withholding thoſe Ores, at a profit of twenty, or even ſuppoſing ten, ℔ cent. would make a great difference in their favour on the balance of their accompts. But I forbear to dwell longer on this diſagreeable ſubject, as I am convinced that moſt of the people concerned in Mining have long beheld with indignation the treatment they meet with, and only want a leader to ſtand forth in their cauſe. (Anonym. Addreſs.)

I proceed to obſerve, in juſtice to the buyers of Copper Ore, that no payment for any commodity can be more punctual than that which is made by them. I cannot recollect one inſtance of tardineſs in all their tranſactions reſpecting their payments; for at the month's end, after the Ores are weighed off, caſh or bills of exchange, almoſt equal in credit to bank notes, are ready for the ſeller's uſe. This cuſtom makes Copper Ore a ready money article, which is of the greateſt conſequence to the neceſſities of the Miners, and in truth cannot be diſpenſed with, unleſs the ſyſtem of Mining be quite changed. However, it muſt be confeſſed that the purchaſer receives ſome gratification to counterbalance his politeneſs: for every ton of Ore (preſuming on a ſuppoſition of waſte) muſt weigh twenty-one hundred weight to the ton; moreover, Ore that is wet by rain is allowed for by a further over-weight according to reaſon and conſcience. At Pol-dyſe Mine the managers will not allow more than four pounds upon every three hundred weight be it wet or dry. The ſamplers demur to this regulation, and contend for four pounds upon dry Ore, and as much more as they can have, for wet. Whoever approves this rapacity muſt be an enemy to the county of Cornwall; for theſe allowances of one hundred weight upon twenty, and four pounds upon every three hundred weight, which is one quarter upon the ton (all together equal to ſix per cent. on the foregoing profits) are more than ten times equivalent for all the wet and waſte they can ſeriouſly pretend to ſuffer. Such is the preſent oppreſſed ſtate of the Copper trade in Cornwall; upon which repreſentation I ſhall reſt at this time, but with an intention on a future day to lay open the ſeveral artifices uſed in that branch of buſineſs in a ſmall pamphlet, for the mature conſideration of the proprietors of Copper Mines in this county.

Preparatory

Preparatory to the final difpofal of Tin, it muft pafs an exchange of Black Tin or Ore for White Tin in blocks, by the way of barter between the Tinner and the Smelter, becaufe the latter is not paid in money for fmelting the Tin, but by deduction of a certain fhare in twenty to himfelf out of the quantity brought to be exchanged. Herein confifts a neceffary fkill in the fmelter: for the Metal of the affay of different kinds of Tin Ore being extremely variable, and not properly refinable in fuch fmall quantities, and the manner of agreeing for or buying the Tin Ore of all forts being to give Tin bills or promiffory notes to the owners thereof, engaging to deliver them at the next coinage fo many hundreds of refined Tin for every twenty hundred weight of the Ore or Black Tin; if the manager in this matter is not a judge how much pure Tin his impure affay will produce, it will become a matter of meer chance whether the Tinner has the real value for his Black Tin, or whether he or the buyer fuffers moft by the exchange. The fmelter's judgment muft be exercifed alfo on another fcore befides that of the finenefs of his affay, as he muft deduct from the quantity of Tin the feller's Ore will produce, as much as he thinks will pay for the fmelting and other incidental charges, together with the profit he propofes to allow himfelf thereupon.

The affay being made, weighed, and calculated, and a judgment formed what proportion thereof is to be allowed the fmelter for his charges and profit, the bufinefs is reduced to a fhort treaty: A has brought to B twenty hundred weight of Black Tin (Tin Ore). Suppofe the produce of this Tin twelve hundred weight; B offers to deliver A, for this, eleven hundred weight at the next coinage; which if A agrees to take, a promiffory note, commonly called a Tin Bill, is given him in the following terms, or nearly fo:

N° 123.

Carvedras, the 8th day of April 1777.

Received of Mr. Anthony Afhley, twenty hundred weight two quarters and fourteen pounds of Black Tin which at eleven for twenty in White Tin is eleven hundred weight one quarter and nine pounds. Which I promife to deliver to him or bearer this Truro coinage.

	C.	Qr.	lb
White Tin	11	1	9.

For H. R. Efq; and Co.

JONAS MILFORD.

This bill being negotiable and payable by an indorfement, the fame as a bill of exchange, the owner thereof may fell it to any one, or at the fmelting-houfe, as moft frequently is the cafe, for fome certain value per hundred weight ; otherwife he may coin the Tin thereof upon his own account. Thefe bills are frequently bought at a nominal value ; the buyer and feller covenanting with each other, that if the real value, when fixed, be different from the nominal, whatever it may be above, the former is to pay to the latter, except one fhilling per hundred weight, the premium for laying out his money ; if under, the feller is to return the difference, and one fhilling per hundred weight, for the reafon juft given. This method of purchafing is called Buying on Difcount ; and the moft ufual way of fettling the real price for fuch Tin has been to fix it at that of the firft hundred blocks bought or fold by any one perfon, of the Tin belonging to that coinage (or quarter) in which fuch bills were bought.

This makes what they call the Tin bill trade fo noted in this county ; for if the Tinner is not of ability to wait the time of the coinage, and perhaps fome time after, till the merchant wants it, upon which alfo two or three months credit muft be added ; he fells the bill for ready cafh to the monied man, who defrays all future charges upon the Tin. The buyer has a further profit upon this Tin of two pounds over-weight upon every hundred weight of White Tin, which the fmelter is obligated to render the bill-holder ; fo that the buyer of the bill has about two fhillings per hundred weight clear profit by this traffick ; and if he can return his money quarterly, which was formerly the cafe, he makes twelve per cent. profit per annum of his cafh. The Tin bill trade was anciently in the hands of the mercantile part of the county, but it now principally refts with the fmelters of the Tin, who take care to operate on the credulity of the Tinner by infinuating that he has a larger exchange of White Tin for his Black when he parts with the former to the fmelter ; and that, in complaifance for his obliging difpofition towards the proprietor of the houfe—This may be true ; but, Fallax vulgi judicium.

There is one confideration that is connected with this fubject, that deferves much more attention than it has ever yet met with. Thefe perfons who ftand between the real and original proprietors of the Tin-ftuff and the exporters, though they have ufually the greateft fhare of the White Tin in their poffeffion, are not to to be looked on as the real fufferers by the low price it bears, or even by a ftagnation of the Tin trade, unlefs it is unforefeen. Thefe gentlemen take care to make all proper deductions on that account when the Tin is brought to them to be fampled; and the difcount on Tin bills, as I have juft obferved, is an additional douceur. I would not be fuppofed even to hint at a combination between the fmelter of the Tin and the manufacturer or exporter: the credit and fortune of many of the former place them above a bare infinuation of this kind. I only mean to affert, that however they may join the general cry on account of the low price of Tin, no thinking perfon will ever fet them down as fufferers thereby. There is a known fact I fhall mention by way of illuftration, viz. That the retailer of any excifeable commodity ftands in the fame predicament, with the merchant who buys to fell again, and has as much reafon to be a lofer on an additional duty laid on that commodity; whereas, on the contrary, he is too frequently a gainer.

Till the reign of Hen. VIII. there were but two coinages a year for Tin, viz. at Midfummer and Michaelmas, when the Tinners by petition and proving the inconveniency arifing from the long vacation between the latter and the former, obtained the liberty to coin their Tin quarterly by adding Chriftmas and Lady-day to the foregoing coinages; for which they pay to the duke of Cornwall an acknowledgment (called Poft-Groats) of fourpence extra for every hundred of White Tin coined in thofe quarters. The privileged towns for coinage of Tin were anciently Lifkeard, Loftwithiel, Truro, and Helfton. For the conveniency of the weftern Tinners, foon after the reftoration Penzance was alfo made a coinage town; in which laft place, there is every quarter abundantly more Tin coined than in all the towns of Lifkeard, Loftwithiel, and Helfton put together, for a whole year.

When the Tin is brought to be coined, it is carried into the coinage hall built on purpofe to receive it, where the affay mafter's deputy affays it by cutting off with a chiffel and hammer a piece of one of the bottom corners of the block about a pound weight, partly by cutting and partly by breaking, in order to prove the toughnefs and finenefs of the Metal. If it is pure good Tin, the face of the block is ftamped with the duchy feal, which ftamp is a permit for the owner to fell, and at the fame time an affurance that the Tin fo marked has been purpofely examined and found merchantable. The ftamping

 this

this impreſſion by a hammer, in like manner as was anciently done to render money current, is coining the Tin, and the man who does it is called the Hammer Man.

The arms of Condorus, laſt earl of Cornwall of Britiſh blood, (Temp. W. I.) were Sable 15 Bezants (5,4,3,2,1) in pale Or. Richard, king of the Romans, earl of Cornwall, ſon to king John, threw theſe Bezants into a border round the bearing of the earl of Poictou: he bore therefore argent, a Lion Rampant Gules, crowned Or within a bordure garniſhed with Bezants: and this ſtill continues the duchy ſeal. Beſides this impreſſion, the Tin bears that alſo of the particular houſe where it was ſmelted, which I have mentioned in my laſt chapter, in order that if there be any deceit uſed in the Tin by any foul mixture (making a pye as they call it, by putting hard heads, &c. in the middle, and lading the Tin to cover the cheat, that it may eſcape the aſſayers notice, which has formerly happened) their roguery may be the more eaſily detected. The credulous believe, that by the old Stannary laws, the perſon convicted of ſuch adulteration and fraudulency was to have three ſpoonfulls of melted Tin poured down his throat; a puniſhment that would effectually ſecure him from a repetition of the ſame act. Beſides the foregoing officers of the coinage, there are numerators to ſet down the number of blocks coined every quarter, together with the ſmelting-houſe numbers, and the weight of each block, all which are carefully regiſtered, that no miſtake ſhall happen, or diſpute ariſe between the revenue officers and the owners of the Tin, or between the latter and the purchaſers, the initials of the original proprietors names being likewiſe ſtamped on every block.

If we extend our examination to the exportation of Tin, we ſhall find that the ancient inhabitants had greatly the advantage of us in this particular. The induſtrious republicans of Africa ſought our Tin with an ardour equal to what we diſcover in fetching gold duſt from the ſhores of that continent; and the coaſting voyage they were obliged to perform from their ignorance of the loadſtone, was attended with more delays and hazard than has been experienced ſince in the circumnavigation of the world. But let us turn our eyes to the reverſe of this picture: poſſeſſed of a numerous and, frequently, ſtarving poor, with the advantage of a harbour, the ſecond in point of ſize and ſafety in the whole iſland, yet where is there a ſingle manufactory of Tin ware among us? The inſtances have been very

very rare alſo, of a direct exportion of Block or Bar Tin to Holland, Turkey, or even to America: on the contrary it is ſhipped for the port of London, and double commiſſion and inſurance is the neceſſary conſequence; at the ſame time that thoſe cargoes which are conſigned to the Mediterranean or American markets muſt repaſs our coaſts, and run a riſk of being caſt on their native ſhore. There is one conſideration more, that I ſhall beg leave to mention; and the inattention is ſo great, that, were it not for the poor labourer whoſe bread depends on the price of his Tin, it would make me diveſt myſelf of compaſſion for every other perſon concerned either as land-holder or adventurer. The conſignments of Tin on commiſſion for foreign markets have fallen, by I know not what infatuation, into the hands of the pewterer in London. His intereſt in keeping down the price of Block Tin, muſt infinitely exceed any degree of percentage he could expect on his commiſſion for exportation. By this means he is enabled to dictate to his principals; and fix the price of the commodity to his own ſtandard. It would be waſting time to dwell on this ſubject. I ſhould gladly have drawn a veil over it, to ſpare the diſgraceful inference that muſt naturally ariſe on the bare mention of it: but as all things have an end, ſo there muſt be ſome period to the ſtrongeſt degree of lethargy; and ſome efforts a few years back made me hope, the gentlemen of the Mining diſtricts would not have wanted any ſhaking to awaken them. But theſe efforts, from the little attention paid to the real ſtate of the Tin trade, will hardly be ſufficient to convince the unprejudiced, that they were fully awake.

T A B L E S,

Shewing what Quantity of White Tin muſt be delivered by the Smelter for any Quantity of Black Tin, from 4 ℔ of White, for 20 ℔ of Black, to 13¾ ℔ of White for 20 ℔ of Black.

At 4 for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	4	1	—	—	22	8
2	—	8	2	—	1	16	16
3	—	12	3	—	2	11	4
4	—	16	4	—	3	5	12
5	1	—	5	1	—	—	—
6	1	4	6	1	—	22	8
7	1	8	7	1	1	16	16
8	1	12	8	1	2	11	4
9	1	16	9	1	3	5	12
10	2	—	10	2	—	—	—
11	2	4	20	4	—	—	—
12	2	8	30	6	—	—	—
13	2	12	40	8	—	—	—
14	2	16	50	10	—	—	—
			60	12	—	—	—
28	5	12	70	14	—	—	—
56	11	4	80	16	—	—	—
84	16	16	90	18	—	—	—
			100	20	—	—	—
			200	40	—	—	—

At 4½ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	4½	1	—	—	25	4
2	—	9	2	—	1	22	8
3	—	13½	3	—	2	19	12
4	—	18	4	—	3	16	16
5	1	2½	5	1	—	14	—
6	1	7	6	1	1	11	4
7	1	11½	7	1	2	8	8
8	1	16	8	1	3	5	12
9	2	½	9	2	—	2	16
10	2	5	10	2	1	—	—
11	2	9½	20	4	2	—	—
12	2	14	30	6	3	—	—
13	2	18½	40	9	—	—	—
14	3	3	50	11	1	—	—
			60	13	2	—	—
28	6	6	70	15	3	—	—
56	12	12	80	18	—	—	—
84	18	18	90	20	1	—	—
			100	22	2	—	—
			200	45	—	—	—

At 4¼ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	4¼	1	—	—	23	16
2	—	8½	2	—	1	19	12
3	—	12¾	3	—	2	15	8
4	—	17	4	—	3	11	4
5	1	1¼	5	1	—	7	—
6	1	5½	6	1	1	2	16
7	1	9¾	7	1	1	26	12
8	1	14	8	1	2	22	8
9	1	18¼	9	1	3	18	4
10	2	2½	10	2	—	14	—
11	2	6¾	20	4	1	—	—
12	2	11	30	6	1	14	—
13	2	15¼	40	8	2	—	—
14	2	19½	50	10	2	14	—
			60	12	3	—	—
28	5	19	70	14	3	14	—
56	11	18	80	17	—	—	—
84	17	17	90	19	—	14	—
			100	21	1	—	—
			200	42	2	—	—

At 4¾ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	4¾	1	—	—	26	12
2	—	9½	2	—	1	25	4
3	—	14¼	3	—	2	23	16
4	—	19	4	—	3	22	8
5	1	3¾	5	1	—	21	—
6	1	8½	6	1	1	19	12
7	1	13¼	7	1	2	18	4
8	1	18	8	1	3	16	16
9	2	2¾	9	2	—	15	8
10	2	7½	10	2	1	14	—
11	2	12¼	20	4	3	—	—
12	2	17	30	7	—	14	—
13	3	1¾	40	9	2	—	—
14	3	6½	50	11	3	14	—
			60	14	1	—	—
28	6	13	70	16	2	14	—
56	13	6	80	19	—	—	—
84	19	19	90	21	1	14	—
			100	23	3	—	—
			200	47	2	—	—

At 5 for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q	lb	20
1	—	5	1	—	1	—	—
2	—	10	2	—	2	—	—
3	—	15	3	—	3	—	—
4	1	—	4	1	—	—	—
5	1	5	5	1	1	—	—
6	1	10	6	1	2	—	—
7	1	15	7	1	3	—	—
8	2	—	8	2	—	—	—
9	2	5	9	2	1	—	—
10	2	10	10	2	2	—	—
11	2	15	20	5	—	—	—
12	3	—	30	7	2	—	—
13	3	5	40	10	—	—	—
14	3	10	50	12	2	—	—
			60	15	—	—	—
28	7	—	70	17	2	—	—
56	14	—	80	20	—	—	—
84	21	—	90	22	2	—	—
			100	25	—	—	—
			200	50	—	—	—

At 5½ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q	lb	20
1	—	5½	1	—	1	2	16
2	—	11	2	—	2	5	12
3	—	16½	3	—	3	8	8
4	1	2	4	1	—	11	4
5	1	7½	5	1	1	14	—
6	1	13	6	1	2	16	16
7	1	18½	7	1	3	19	12
8	2	4	8	2	—	22	8
9	2	9½	9	2	1	25	4
10	2	15	10	2	3	—	—
11	3	½	20	5	2	—	—
12	3	6	30	8	1	—	—
13	3	11½	40	11	—	—	—
14	3	17	50	13	3	—	—
			60	16	2	—	—
28	7	14	70	19	1	—	—
56	15	8	80	22	—	—	—
84	23	2	90	24	3	—	—
			100	27	2	—	—
			200	55	—	—	—

At 5¼ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q	lb	20
1	—	5¼	1	—	1	1	8
2	—	10½	2	—	2	2	16
3	—	15¾	3	—	3	4	4
4	1	1	4	1	—	5	12
5	1	6¼	5	1	1	7	—
6	1	11½	6	1	2	8	8
7	1	16¾	7	1	3	9	16
8	2	2	8	2	—	11	4
9	2	7¼	9	2	1	12	12
10	2	12½	10	2	2	14	—
11	2	17¾	20	5	1	—	—
12	3	3	30	7	3	14	—
13	3	8¼	40	10	2	—	—
14	3	13½	50	13	—	14	—
			60	15	3	—	—
28	7	7	70	18	1	14	—
56	14	14	80	21	—	—	—
84	22	1	90	23	2	14	—
			100	26	1	—	—
			200	52	2	—	—

At 5¾ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q	lb	20
1	—	5¾	1	—	1	4	4
2	—	11½	2	—	2	8	8
3	—	17¼	3	—	3	12	12
4	1	3	4	1	—	16	16
5	1	8¾	5	1	1	21	—
6	1	14½	6	1	2	25	4
7	2	¼	7	2	—	1	8
8	2	6	8	2	1	5	12
9	2	11¾	9	2	2	9	16
10	2	17½	10	2	3	14	—
11	3	3¼	20	5	3	—	—
12	3	9	30	8	2	14	—
13	3	14¾	40	11	2	—	—
14	4	½	50	14	1	14	—
			60	17	1	—	—
28	8	1	70	20	—	14	—
56	16	2	80	23	—	—	—
84	24	3	90	25	3	14	—
			100	28	3	—	—
			200	57	2	—	—

At 6 for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	6	1	—	1	5	12
2	—	12	2	—	2	11	4
3	—	18	3	—	3	16	16
4	1	4	4	1	—	22	8
5	1	10	5	1	2	—	—
6	1	16	6	1	3	5	12
7	2	2	7	2	—	11	4
8	2	8	8	2	1	16	16
9	2	14	9	2	2	22	8
10	3	—	10	3	—	—	—
11	3	6	20	6	—	—	—
12	3	12	30	9	—	—	—
13	3	18	40	12	—	—	—
14	4	4	50	15	—	—	—
			60	18	—	—	—
28	8	8	70	21	—	—	—
56	16	16	80	24	—	—	—
84	25	4	90	27	—	—	—
			100	30	—	—	—
			200	60	—	—	—

At 6½ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	6½	1	—	1	8	8
2	—	13	2	—	2	16	16
3	—	19½	3	—	3	25	4
4	1	6	4	1	1	5	12
5	1	12½	5	1	2	14	—
6	1	19	6	1	3	22	8
7	2	5½	7	2	1	2	16
8	2	12	8	2	2	11	4
9	2	18½	9	2	3	19	12
10	3	5	10	3	1	—	—
11	3	11½	20	6	2	—	—
12	3	18	30	9	3	—	—
13	4	4½	40	13	—	—	—
14	4	11	50	16	1	—	—
			60	19	2	—	—
28	9	2	70	22	3	—	—
56	18	4	80	26	—	—	—
84	27	6	90	29	1	—	—
			100	32	2	—	—
			200	65	—	—	—

At 6¼ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	6¼	1	—	1	7	—
2	—	12½	2	—	2	14	—
3	—	18¾	3	—	3	21	—
4	1	5	4	1	1	—	—
5	1	11¼	5	1	2	7	—
6	1	17½	6	1	3	14	—
7	2	3¾	7	2	—	21	—
8	2	10	8	2	2	—	—
9	2	16¼	9	2	3	7	—
10	3	2½	10	3	—	14	—
11	3	8¾	20	6	1	—	—
12	3	15	30	9	1	14	—
13	4	1¼	40	12	2	—	—
14	4	7½	50	15	2	14	—
			60	18	3	—	—
28	8	15	70	21	3	14	—
56	17	10	80	25	—	—	—
84	26	5	90	28	—	14	—
			100	31	1	—	—
			200	62	2	—	—

At 6¾ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	6¾	1	—	1	9	16
2	—	13½	2	—	2	19	12
3	1	¼	3	1	—	1	8
4	1	7	4	1	1	11	4
5	1	13¾	5	1	2	21	—
6	2	½	6	2	—	2	16
7	2	7¼	7	2	1	12	12
8	2	14	8	2	2	22	8
9	3	¾	9	3	—	4	4
10	3	7½	10	3	1	14	—
11	3	14¼	20	6	3	—	—
12	4	1	30	10	—	14	—
13	4	7¾	40	13	2	—	—
14	4	14½	50	16	3	14	—
			60	20	1	—	—
28	9	9	70	23	2	14	—
56	18	18	80	27	—	—	—
84	28	7	90	30	1	14	—
			100	33	3	—	—
			200	67	2	—	—

At 7 for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q	lb	20
1	—	7	1	—	1	11	4
2	—	14	2	—	2	22	8
3	1	1	3	1	—	5	12
4	1	8	4	1	1	16	16
5	1	15	5	1	3	—	—
6	2	2	6	2	—	11	4
7	2	9	7	2	1	22	8
8	2	16	8	2	3	5	12
9	3	3	9	3	—	16	16
10	3	10	10	3	2	—	—
11	3	17	20	7	—	—	—
12	4	4	30	10	2	—	—
13	4	11	40	14	—	—	—
14	4	18	50	17	2	—	—
			60	21	—	—	—
28	9	16	70	24	2	—	—
56	19	12	80	28	—	—	—
84	29	8	90	31	2	—	—
			100	35	—	—	—
			200	70	—	—	—

At 7½ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q	lb	20
1	—	7½	1	—	1	14	—
2	—	15	2	—	3	—	—
3	1	2½	3	1	—	14	—
4	1	10	4	1	2	—	—
5	1	17½	5	1	3	14	—
6	2	5	6	2	1	—	—
7	2	12½	7	2	2	14	—
8	3	—	8	3	—	—	—
9	3	7½	9	3	1	14	—
10	3	15	10	3	3	—	—
11	4	2½	20	7	2	—	—
12	4	10	30	11	1	—	—
13	4	17½	40	15	—	—	—
14	5	5	50	18	3	—	—
			60	22	2	—	—
28	10	10	70	26	1	—	—
56	21	—	80	30	—	—	—
84	31	10	90	33	3	—	—
			100	37	2	—	—
			200	75	—	—	—

At 7¼ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q	lb	20
1	—	7¼	1	—	1	12	12
2	—	14½	2	—	2	25	4
3	1	1¾	3	1	—	9	16
4	1	9	4	1	1	22	8
5	1	16¼	5	1	3	7	—
6	2	3½	6	2	—	19	12
7	2	10¾	7	2	2	4	4
8	2	18	8	2	3	16	16
9	3	5¼	9	2	1	1	8
10	3	12½	10	3	2	14	—
11	3	19¾	20	7	1	—	—
12	4	7	30	10	3	14	—
13	4	14¼	40	14	2	—	—
14	5	1½	50	18	—	14	—
			60	21	3	—	—
28	10	3	70	25	1	14	—
56	20	6	80	29	—	—	—
84	30	9	90	32	2	14	—
			100	36	1	—	—
			200	72	2	—	—

At 7¾ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q	lb	20
1	—	7¾	1	—	1	15	8
2	—	15½	2	—	3	2	16
3	1	3¼	3	1	—	18	4
4	1	11	4	1	2	5	12
5	1	18¾	5	1	3	21	—
6	2	6½	6	2	1	8	8
7	2	14¼	7	2	2	23	16
8	3	2	8	3	—	11	4
9	3	9¾	9	3	1	26	12
10	3	17½	10	3	3	14	—
11	4	5¼	20	7	3	—	—
12	4	13	30	11	2	14	—
13	5	¾	40	15	2	—	—
14	5	8½	50	19	1	14	—
			60	23	1	—	—
28	10	17	70	27	—	14	—
56	21	14	80	31	—	—	—
84	32	11	90	34	3	14	—
			100	38	3	—	—
			200	77	2	—	—

At 8 for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	8	1	—	1	16	16
2	—	16	2	—	3	5	12
3	1	4	3	1	—	22	8
4	1	12	4	1	2	11	4
5	2	—	5	2	—	—	—
6	2	8	6	2	1	16	16
7	2	16	7	2	3	5	12
8	3	4	8	3	—	22	8
9	3	12	9	3	2	11	4
10	4	—	10	4	—	—	—
11	4	8	20	8	—	—	—
12	4	16	30	12	—	—	—
13	5	4	40	16	—	—	—
14	5	12	50	20	—	—	—
			60	24	—	—	—
28	11	4	70	28	—	—	—
56	22	8	80	32	—	—	—
84	33	12	90	36	—	—	—
			100	40	—	—	—
			200	80	—	—	—

At 8½ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	8½	1	—	1	19	12
2	—	17	2	—	3	11	4
3	1	5½	3	1	1	2	16
4	1	14	4	1	2	22	8
5	2	2½	5	2	—	14	—
6	2	11	6	2	2	5	12
7	2	19½	7	2	3	25	4
8	3	8	8	3	1	16	16
9	3	16½	9	3	3	8	8
10	4	5	10	4	1	—	—
11	4	13½	20	8	2	—	—
12	5	2	30	12	3	—	—
13	5	10½	40	17	—	—	—
14	5	19	50	21	1	—	—
			60	25	2	—	—
28	11	18	70	29	3	—	—
56	23	16	80	34	—	—	—
84	35	14	90	38	1	—	—
			100	42	2	—	—
			200	85	—	—	—

At 8¼ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	8¼	1	—	1	18	4
2	—	16½	2	—	3	8	8
3	1	4¾	3	1	—	26	12
4	1	13	4	1	2	16	16
5	2	1¼	5	2	—	7	—
6	2	9½	6	2	1	25	4
7	2	17¾	7	2	3	15	8
8	3	6	8	3	1	5	12
9	3	14¼	9	3	2	23	16
10	4	2½	10	4	—	14	—
11	4	10¾	20	8	1	—	—
12	4	19	30	12	1	14	—
13	5	7¼	40	16	2	—	—
14	5	15½	50	20	2	14	—
			60	24	3	—	—
28	11	11	70	28	3	14	—
56	23	2	80	33	—	—	—
84	34	13	90	37	—	14	—
			100	41	1	—	—
			200	82	2	—	—

At 8¾ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	8¾	1	—	1	21	—
2	—	17½	2	—	3	14	—
3	1	6¼	3	1	1	7	—
4	1	15	4	1	3	—	—
5	2	3¾	5	2	—	21	—
6	2	12½	6	2	2	14	—
7	3	1¼	7	3	—	7	—
8	3	10	8	3	2	—	—
9	3	18¾	9	3	3	21	—
10	4	7½	10	4	1	14	—
11	4	16¼	20	8	3	—	—
12	5	5	30	13	—	14	—
13	5	13¾	40	17	2	—	—
14	6	2½	50	21	3	14	—
			60	26	1	—	—
28	12	5	70	30	2	14	—
56	24	10	80	35	—	—	—
84	36	15	90	39	1	14	—
			100	43	3	—	—
			200	87	2	—	—

At 9 for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q.	lb	20
1	—	9	1	—	1	22	8
2	—	18	2	—	3	16	16
3	1	7	3	1	1	11	4
4	1	16	4	1	3	5	12
5	2	5	5	2	1	—	—
6	2	14	6	2	2	22	8
7	3	3	7	3	—	16	16
8	3	12	8	3	2	11	4
9	4	1	9	4	—	5	12
10	4	10	10	4	2	—	—
11	4	19	20	9	—	—	—
12	5	8	30	13	2	—	—
13	5	17	40	18	—	—	—
14	6	6	50	22	2	—	—
			60	27	—	—	—
28	12	12	70	31	2	—	—
56	25	4	80	36	—	—	—
84	37	16	90	40	2	—	—
			100	45	—	—	—
			200	90	—	—	—

At 9½ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q.	lb	20
1	—	9½	1	—	1	25	4
2	—	19	2	—	3	22	8
3	1	8½	3	1	1	19	12
4	1	18	4	1	3	16	16
5	2	7½	5	2	1	14	—
6	2	17	6	2	3	11	4
7	3	6½	7	3	1	8	8
8	3	16	8	3	3	5	12
9	4	5½	9	4	1	2	16
10	4	15	10	4	3	—	—
11	5	4½	20	9	2	—	—
12	5	14	30	14	1	—	—
13	6	3½	40	19	—	—	—
14	6	13	50	23	3	—	—
			60	28	2	—	—
28	13	6	70	33	1	—	—
56	26	12	80	38	—	—	—
84	39	18	90	42	3	—	—
			100	47	2	—	—
			200	95	—	—	—

At 9¼ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q.	lb	20
1	—	9¼	1	—	1	23	16
2	—	18½	2	—	3	19	12
3	1	7¾	3	1	1	15	8
4	1	17	4	1	3	11	4
5	2	6¼	5	2	1	7	—
6	2	15½	6	2	3	2	16
7	3	4¾	7	3	—	26	12
8	3	14	8	3	2	22	8
9	4	3¼	9	4	—	18	4
10	4	12½	10	4	2	14	—
11	5	1¾	20	9	1	—	—
12	5	11	30	13	3	14	—
13	6	¼	40	18	2	—	—
14	6	9½	50	23	—	14	—
			60	27	3	—	—
28	12	19	70	32	1	14	—
56	25	18	80	37	—	—	—
84	38	17	90	41	2	14	—
			100	46	1	—	—
			200	92	—	—	—

At 9¾ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
lb	lb	20	C.	C.	Q.	lb	20
1	—	9¾	1	—	1	26	12
2	—	19½	2	—	3	25	4
3	1	9¼	3	1	1	23	16
4	1	19	4	1	3	22	8
5	2	8¾	5	2	1	21	—
6	2	18½	6	2	3	19	12
7	3	8¼	7	3	1	18	4
8	3	18	8	3	3	16	16
9	4	7¾	9	4	1	15	8
10	4	17½	10	4	3	14	—
11	5	7¼	20	9	3	—	—
12	5	17	30	14	2	14	—
13	6	6¾	40	19	2	—	—
14	6	16½	50	24	1	14	—
			60	29	1	—	—
28	13	13	70	34	—	14	—
56	27	6	80	39	—	—	—
84	40	19	90	43	3	14	—
			100	48	3	—	—
			200	97	2	—	—

At 10 for 20

Bl. Tin ℔	White Tin ℔	White Tin 20	Bl. Tin C.	White Tin C.	Q	℔	20
1	—	10	1	—	2	—	—
2	1	—	2	1	—	—	—
3	1	10	3	1	2	—	—
4	2	—	4	2	—	—	—
5	2	10	5	2	2	—	—
6	3	—	6	3	—	—	—
7	3	10	7	3	2	—	—
8	4	—	8	4	—	—	—
9	4	10	9	4	2	—	—
10	5	—	10	5	—	—	—
11	5	10	20	10	—	—	—
12	6	—	30	15	—	—	—
13	6	10	40	20	—	—	—
14	7	—	50	25	—	—	—
			60	30	—	—	—
28	14	—	70	35	—	—	—
56	28	—	80	40	—	—	—
84	42	—	90	45	—	—	—
			100	50	—	—	—
			200	100	—	—	—

At 10½ for 20

Bl. Tin ℔	White Tin ℔	White Tin 20	Bl. Tin C.	White Tin C.	Q	℔	20
1	—	10½	1	—	2	2	16
2	1	1	2	1	—	5	12
3	1	11½	3	1	2	8	8
4	2	2	4	2	—	11	4
5	2	12½	5	2	2	14	—
6	3	3	6	3	—	16	16
7	3	13½	7	3	2	19	12
8	4	4	8	4	—	22	8
9	4	14½	9	4	2	25	4
10	5	5	10	5	1	—	—
11	5	15½	20	10	2	—	—
12	6	6	30	15	3	—	—
13	6	16½	40	21	—	—	—
14	7	7	50	26	1	—	—
			60	31	2	—	—
28	14	14	70	36	3	—	—
56	29	8	80	42	—	—	—
84	44	2	90	47	1	—	—
			100	52	2	—	—
			200	105	—	—	—

At 10¼ for 20

Bl. Tin ℔	White Tin ℔	White Tin 20	Bl. Tin C.	White Tin C.	Q	℔	20
1	—	10¼	1	—	2	1	8
2	1	—½	2	1	—	2	16
3	1	10¾	3	1	2	4	4
4	2	1	4	2	—	5	12
5	2	11¼	5	2	2	7	—
6	3	1½	6	3	—	8	8
7	3	11¾	7	3	2	9	16
8	4	2	8	4	—	11	4
9	4	12¼	9	4	2	12	12
10	5	2½	10	5	—	14	—
11	5	12¾	20	10	1	—	—
12	6	3	30	15	1	14	—
13	6	13¼	40	20	2	—	—
14	7	3½	50	25	2	14	—
			60	30	3	—	—
28	14	7	70	35	3	14	—
56	28	14	80	41	—	—	—
84	43	1	90	46	—	14	—
			100	51	1	—	—
			200	102	2	—	—

At 10¾ for 20

Bl. Tin ℔	White Tin ℔	White Tin 20	Bl. Tin C.	White Tin C.	Q	℔	20
1	—	10¾	1	—	2	4	4
2	1	1½	2	1	—	8	8
3	1	12¼	3	1	2	12	12
4	2	3	4	2	—	16	16
5	2	13¾	5	2	2	21	—
6	3	4½	6	3	—	25	4
7	3	15¼	7	3	3	1	8
8	4	6	8	4	1	5	12
9	4	16¾	9	4	3	9	16
10	5	7½	10	5	1	14	—
11	5	18¼	20	10	3	—	—
12	6	9	30	16	—	14	—
13	6	19¾	40	21	2	—	—
14	7	10½	50	26	3	14	—
			60	32	1	—	—
28	15	1	70	37	2	14	—
56	30	2	80	43	—	—	—
84	45	3	90	48	1	14	—
			100	53	3	—	—
			200	107	2	—	—

At 11 for 20

Bl. Tin ℔	White Tin ℔	White Tin 20	Bl. Tin C.	White Tin C.	Q	℔	20
1	—	11	1	—	2	5	12
2	1	2	2	1	—	11	4
3	1	13	3	1	2	16	16
4	2	4	4	2	—	22	8
5	2	15	5	2	3	—	—
6	3	6	6	3	1	5	12
7	3	17	7	3	3	11	4
8	4	8	8	4	1	16	16
9	4	19	9	4	3	22	8
10	5	10	10	5	2	—	—
11	6	1	20	11	—	—	—
12	6	12	30	16	2	—	—
13	7	3	40	22	—	—	—
14	7	14	50	27	2	—	—
			60	33	—	—	—
28	15	8	70	38	2	—	—
56	30	16	80	44	—	—	—
84	46	4	90	49	2	—	—
			100	55	—	—	—
			200	110	—	—	—

At 11½ for 20

Bl. Tin ℔	White Tin ℔	White Tin 20	Bl. Tin C.	White Tin C.	Q	℔	20
1	—	11½	1	—	2	8	8
2	1	3	2	1	—	16	16
3	1	14½	3	1	2	25	4
4	2	6	4	2	1	5	12
5	2	17½	5	2	3	14	—
6	3	9	6	3	1	22	8
7	4	½	7	4	—	2	16
8	4	12	8	4	2	11	4
9	5	3½	9	5	—	19	12
10	5	15	10	5	3	—	—
11	6	6½	20	11	2	—	—
12	6	18	30	17	1	—	—
13	7	9½	40	23	—	—	—
14	8	1	50	28	3	—	—
			60	34	2	—	—
28	16	2	70	40	1	—	—
56	32	4	80	46	—	—	—
84	48	6	90	51	3	—	—
			100	57	2	—	—
			200	115	—	—	—

At 11¼ for 20

Bl. Tin ℔	White Tin ℔	White Tin 20	Bl. Tin C.	White Tin C.	Q	℔	20
1	—	11¼	1	—	2	7	—
2	1	2½	2	1	—	14	—
3	1	13¾	3	1	2	21	—
4	2	5	4	2	1	—	—
5	2	16¼	5	2	3	7	—
6	3	7½	6	3	1	14	—
7	3	18¾	7	3	3	21	—
8	4	10	8	4	2	—	—
9	5	1¼	9	5	—	7	—
10	5	12½	10	5	2	14	—
11	6	3¾	20	11	1	—	—
12	6	15	30	16	3	14	—
13	7	6¼	40	22	2	—	—
14	7	17½	50	28	—	14	—
			60	33	3	—	—
28	15	15	70	39	1	14	—
56	31	10	80	45	—	—	—
84	47	5	90	50	2	14	—
			100	56	1	—	—
			200	112	2	—	—

At 11¾ for 20

Bl. Tin ℔	White Tin ℔	White Tin 20	Bl. Tin C.	White Tin C.	Q	℔	20
1	—	11¾	1	—	2	9	16
2	1	3½	2	1	—	19	12
3	1	15¼	3	1	3	1	8
4	2	7	4	2	1	11	4
5	2	18¾	5	2	3	21	—
6	3	10½	6	3	2	2	16
7	4	2¼	7	4	—	12	12
8	4	14	8	4	2	22	8
9	5	5¾	9	5	1	4	4
10	5	17½	10	5	3	14	—
11	6	9¼	20	11	3	—	—
12	7	1	30	17	2	14	—
13	7	12¾	40	23	2	—	—
14	8	4½	50	29	1	14	—
			60	35	1	—	—
28	16	9	70	41	—	14	—
56	32	18	80	47	—	—	—
84	49	7	90	52	3	14	—
			100	58	3	—	—
			200	117	2	—	—

At 12 for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	12	1	—	2	11	4
2	1	4	2	1	—	22	8
3	1	16	3	1	3	5	12
4	2	8	4	2	1	16	16
5	3	—	5	3	—	—	—
6	3	12	6	3	2	11	4
7	4	4	7	4	—	22	8
8	4	16	8	4	3	5	12
9	5	8	9	5	1	16	16
10	6	—	10	6	—	—	—
11	6	12	20	12	—	—	—
12	7	4	30	18	—	—	—
13	7	16	40	24	—	—	—
14	8	8	50	30	—	—	—
			60	36	—	—	—
28	16	16	70	42	—	—	—
56	33	12	80	48	—	—	—
84	50	8	90	54	—	—	—
			100	60	—	—	—
			200	120	—	—	—

At $12\frac{1}{2}$ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	$12\frac{1}{2}$	1	—	2	14	—
2	1	5	2	1	1	—	—
3	1	$17\frac{1}{2}$	3	1	3	14	—
4	2	10	4	2	2	—	—
5	3	$2\frac{1}{2}$	5	3	—	14	—
6	3	15	6	3	3	—	—
7	4	$7\frac{1}{2}$	7	4	1	14	—
8	5	—	8	5	—	—	—
9	5	$12\frac{1}{2}$	9	5	2	14	—
10	6	5	10	6	1	—	—
11	6	$17\frac{1}{2}$	20	12	2	—	—
12	7	10	30	18	3	—	—
13	8	$2\frac{1}{2}$	40	25	—	—	—
14	8	15	50	31	1	—	—
			60	37	2	—	—
28	17	10	70	43	3	—	—
56	35	—	80	50	—	—	—
84	52	10	90	56	1	—	—
			100	62	2	—	—
			200	125	—	—	—

At $12\frac{1}{4}$ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	$12\frac{1}{4}$	1	—	2	12	12
2	1	$4\frac{1}{2}$	2	1	—	25	4
3	1	$16\frac{3}{4}$	3	1	3	9	16
4	2	9	4	2	1	22	8
5	3	$1\frac{1}{4}$	5	3	—	7	—
6	3	$13\frac{1}{2}$	6	3	2	19	12
7	4	$5\frac{3}{4}$	7	4	1	4	4
8	4	18	8	4	3	16	16
9	5	$10\frac{1}{4}$	9	5	2	1	8
10	6	$2\frac{1}{2}$	10	6	—	14	—
11	6	$14\frac{3}{4}$	20	12	1	—	—
12	7	7	30	18	1	14	—
13	7	$19\frac{1}{4}$	40	24	2	—	—
14	8	$11\frac{1}{2}$	50	30	2	14	—
			60	36	3	—	—
28	17	3	70	42	3	14	—
56	34	6	80	49	—	—	—
84	51	9	90	55	—	14	—
			100	61	1	—	—
			200	122	2	—	—

At $12\frac{3}{4}$ for 20

Bl. Tin	White Tin		Bl. Tin	White Tin			
℔	℔	20	C.	C.	Q	℔	20
1	—	$12\frac{3}{4}$	1	—	2	15	8
2	1	$5\frac{1}{2}$	2	1	1	2	16
3	1	$18\frac{1}{4}$	3	1	3	18	4
4	2	11	4	2	2	5	12
5	3	$3\frac{3}{4}$	5	3	—	21	—
6	3	$16\frac{1}{2}$	6	3	3	8	8
7	4	$9\frac{1}{4}$	7	4	1	23	16
8	5	2	8	5	—	11	4
9	5	$14\frac{3}{4}$	9	5	2	26	12
10	6	$7\frac{1}{2}$	10	6	1	14	—
11	7	$\frac{1}{4}$	20	12	3	—	—
12	7	13	30	19	—	14	—
13	8	$5\frac{3}{4}$	40	25	2	—	—
14	8	$18\frac{1}{2}$	50	31	3	14	—
			60	38	1	—	—
28	17	17	70	44	2	14	—
56	35	14	80	51	—	—	—
84	53	11	90	57	1	14	—
			100	63	3	—	—
			200	127	2	—	—

At 13 for 20

Bl. Tin lb	White Tin lb	White Tin 20	Bl. Tin C.	White Tin C.	Q	lb	20
1	—	13	1	—	2	16	16
2	1	6	2	1	1	5	12
3	1	19	3	1	3	22	8
4	2	12	4	2	2	11	4
5	3	5	5	3	1	—	—
6	3	18	6	3	3	16	8
7	4	11	7	4	2	5	12
8	5	4	8	5	—	22	8
9	5	17	9	5	3	11	4
10	6	10	10	6	2	—	—
11	7	3	20	13	—	—	—
12	7	16	30	19	2	—	—
13	8	9	40	26	—	—	—
14	9	2	50	32	2	—	—
			60	39	—	—	—
28	18	4	70	45	2	—	—
56	36	8	80	52	—	—	—
84	54	12	90	58	2	—	—
			100	65	—	—	—
			200	130	—	—	—

At 13½ for 20

Bl. Tin lb	White Tin lb	White Tin 20	Bl. Tin C.	White Tin C.	Q	lb	20
1	—	13½	1	—	2	19	12
2	1	7	2	1	1	11	4
3	2	½	3	2	—	2	16
4	2	14	4	2	2	22	8
5	3	7½	5	3	1	14	—
6	4	1	6	4	—	5	12
7	4	14½	7	4	2	25	4
8	5	8	8	5	1	16	16
9	6	1½	9	6	—	8	8
10	6	15	10	6	3	—	—
11	7	8½	20	13	2	—	—
12	8	2	30	20	1	—	—
13	8	15½	40	27	—	—	—
14	9	9	50	33	3	—	—
			60	40	2	—	—
28	18	18	70	47	1	—	—
56	37	16	80	54	—	—	—
84	56	14	90	60	3	—	—
			100	67	2	—	—
			200	135	—	—	—

At 13¼ for 20

Bl. Tin lb	White Tin lb	White Tin 20	Bl. Tin C.	White Tin C.	Q	lb	20
1	—	13¼	1	—	2	18	4
2	1	6½	2	1	1	8	8
3	1	19¾	3	1	3	26	12
4	2	13	4	2	2	16	16
5	3	6¼	5	3	1	7	—
6	3	19½	6	3	3	25	4
7	4	12¾	7	4	2	15	8
8	5	6	8	5	1	5	12
9	5	19¼	9	5	3	23	16
10	6	12½	10	6	2	14	—
11	7	5¾	20	13	1	—	—
12	7	19	30	19	3	14	—
13	8	12¼	40	26	2	—	—
14	9	5½	50	33	—	14	—
			60	39	3	—	—
28	18	11	70	46	1	14	—
56	37	2	80	53	—	—	—
84	55	13	90	59	2	14	—
			100	66	1	—	—
			200	132	2	—	—

At 13¾ for 20

Bl. Tin lb	White Tin lb	White Tin 20	Bl. Tin C.	White Tin C.	Q	lb	20
1	—	13¾	1	—	2	21	—
2	1	7½	2	1	1	14	—
3	2	1¼	3	2	—	7	—
4	2	15	4	2	3	—	—
5	3	8¾	5	3	1	21	—
6	4	2½	6	4	—	14	—
7	4	16¼	7	4	3	7	—
8	5	10	8	5	2	—	—
9	6	3¾	9	6	—	21	—
10	6	17½	10	6	3	14	—
11	7	11¼	20	13	3	—	—
12	8	5	30	20	2	14	—
13	8	18¾	40	27	2	—	—
14	9	12½	50	34	1	14	—
			60	41	1	—	—
28	19	5	70	48	—	14	—
56	38	10	80	55	—	—	—
84	57	15	90	61	3	14	—
			100	68	3	—	—
			200	137	2	—	—

APPENDIX.

AMONG the variety of improvements that may be fuggefted for the intereft of Mining, thofe certainly are moft beneficial, which tend to the perfection of mechanicks and hydraulicks; for had there not been great progrefs made in thofe branches of philofophy within the laft improved ages of fcience, Mining would ftill confift of merely digging a few fathoms deep, and raifing the ftuff and water, by dint of human labour.

About four-fcore years back, fmall wheels of twelve or fifteen feet diameter, were thought the beft machinery for draining the Mines; and if one or two were infufficient, more were often applied to that purpofe, all worked by the fame ftream of water. I have heard of feven in one Mine, worked over each other. This power muft have been attended with a complication of accidents and delays. However, foon after the above date, Mr. John Coftar, of Briftol, came into this county, and taught the natives an improvement in this machinery, by demolifhing thofe petit engines, and fubftituting one large wheel of between thirty and forty feet diameter in their ftead.

Hitherto we are all affured, that a large water wheel engine, if water is plenty and cheap, is moft effectual and fteady for the purpofe of draining our Mines; but this power is limited; and beyond a certain gauge we dare not undertake. We know, that if we add to our power, we experience a lofs in time or motion, more than equivalent to the acquifition. Upon this principle we underftand, that a thirty-eight feet wheel, or thereabout, is the beft medium we can prefcribe to ourfelves; purfuant to which we know, that, beyond a certain depth, we cannot fink with eafe and conveniency to our intereft; and that another power becomes neceffary for our purpofe.

It fhould feem as if we had been led by the kind hand of Providence in thofe difcoveries; for as foon as we found out the ne plus ultra of the power of water, and the neceffity of further

further improvements in hydraulicks, a new and more ſcientifick machinery preſented itſelf to the attention of the Miner. For want of another piece of machinery, we had been ſtinted to a certain depth, beyond which the ſucceeding generation by the water wheel and bobs would be unable to ſink. So that, happily for us and our poſterity, Mr. Newcomen's invention of the ſteam fire engine, even in the weakneſs of its infancy, promiſed that future excellence to which it is ſince arrived, whereby we are enabled to ſink our Mines to twice the depth we could formerly do by any other machinery.

Since the improvement of this machine's working itſelf, by opening and cloſing the regulator and injection cock, moſt other attempts have been very unſucceſsful. The vaſt conſumption of fuel in thoſe engines, is an immenſe drawback upon the profits of our Mines. It is a known fact, that every fire engine of magnitude conſumes to the amount of three thouſand pounds worth of coal in every year. This heavy tax upon Mining, in ſome reſpects, amounts to a prohibition. No wonder then, that we ſhould be more deſirous to leſſen the expence of maintenance in thoſe devouring automatons, than frugal in their erection. Many trials of mechanical ſkill have been made by our engineers, to very little purpoſe, for the total application of heat and the ſaving of fuel. The fire place has been diminiſhed, and enlarged again; the flame has been carried round from the bottom of the boiler in a ſpiral direction, and conveyed through the body of the water in a tube (one, two, or three) before its arrival to the chimney; ſome have uſed a double boiler, ſo that fire might act in every poſſible point of contact; and ſome have built a Moorſtone boiler, heated by three tubes of flame paſſing through it.

Indeed, the only improvement which has been made in the fire engine for thirty years paſt, the publick will very juſtly attribute to the ſagacity of Mr. Watt, whoſe ſkill in pneumaticks, mechanicks, and hydraulicks, is evidenced by the powerful application of elaſtick vapour, and by making a more perfect vacuum, nearly like that of the barometer, in his new conſtructed fire engine.

But before I can explain Mr. Watt's engines, it is neceſſary to premiſe a ſhort account of the imperfections of the common ſteam engines, and their cauſes.

The

The ſteam, or vapour, which ariſes from water confined in a cloſe veſſel, and heated a few degrees above the point at which it boils in the open air, becomes an elaſtick fluid uniform and tranſparent, about half the gravity of atmoſpherick air, very much greater in bulk than the water of which it is compoſed, and capable of being again reduced to water, when brought into contact with matter of a leſs degree of heat than itſelf.

The preſſure of the atmoſphere, or any equivalent reſiſtance, prevents the production of ſteam, until the water be heated to 212 degrees of Fahrenheit's thermometer; but when that preſſure is removed, or the water placed in a veſſel exhauſted of air, ſteam is produced from it, when it is colder than the human blood. On the contrary, if water be preſſed upon by air or ſteam, which are more compreſſed than the atmoſphere, a degree of heat above 212 degrees is neceſſary for the production of ſteam; and the difference of heats, at which water boils under different preſſures, increaſes in a leſs proportion than the preſſures themſelves: ſo that a double preſſure requires leſs than a double increaſe of ſenſible heat.

The experiments which have been publiſhed concerning the bulk of water, when converted into ſteam, are erroneous, and the concluſions drawn from them make that bulk greater than it really is. It has been known for ſome time, that water would boil in an exhauſted receiver, at a low degree of heat; but Mr. Watt was the firſt that made a regular ſet of experiments upon the ſubject, and determined the progreſſion in which the heats followed under various preſſures; and, at the ſame time, made experiments that were deciſive upon the true bulk of ſteam, when compared to the water it is compoſed of. The reſult of theſe experiments he intends to lay before the publick, in a treatiſe upon that ſubject.

If we conſider the common ſteam engine, we ſhall find it defective; firſt, becauſe the vacuum is produced by throwing cold water into the cylinder to condenſe the ſteam; that water becomes hot, and being in a veſſel partially exhauſted produces a ſteam, which in part reſiſts the preſſure of the atmoſphere upon the piſton, and leſſens the power of the engine. The ſecond defect is the deſtruction of ſteam, which unavoidably happens upon attempting to fill a cold cylinder with that fluid: for the injection water, at the ſame time that it condenſes the

 ſteam,

ſteam, not only cools the cylinder but remains there, until it be extruded at the eduction pipe, by the ſteam which is let in to fill the cylinder for the next ſtroke; and that ſteam will be condenſed into water as faſt as it enters, until all the matter it comes into contact with be nearly as hot as itſelf.

Every attempt to make the vacuum more perfect by the addition of injection water, will cool the cylinder more effectually, and cauſe a greater deſtruction of ſteam in the next filling; and if the engine hath already a proper load, the deſtruction of ſteam will proceed in a greater ratio, than the increaſe of power by the amendment of the vacuum.

Though it appears, that the conſtructors of ſteam engines have never inveſtigated theſe cauſes; yet they have been ſo ſenſible of the effects, that a judicious engineer does not attempt to load his engine with a column of water, heavier than ſeven pounds for each ſquare inch of the area of the piſton.

Mr. Watt's improvement is founded upon theſe, and ſome other collateral obſervations. He preſerves an uniform heat in the cylinder of his engines, by ſuffering no cold water to touch it, and by protecting it from the air, or other cold bodies, by a ſurrounding caſe filled with the ſteam, or with hot air or water, and by coating it over with ſubſtances that tranſmit heat ſlowly. He makes his vacuum to approach nearly to that of the barometer, by condenſing the ſteam in a ſeparate veſſel, called the Condenſer, which may be cooled at pleaſure without cooling the cylinder, either by an injection of cold water, or by ſurrounding the condenſer with it, and generally by both. He extracts the injection water and detached air, from the cylinder or condenſer, by pumps which are wrought by the engine itſelf, or he blows it out by the ſteam. As the entrance of air into the cylinder would ſtop the operation of the engines, and as it is hardly to be expected that ſuch enormous piſtons, as thoſe of ſteam engines, can move up and down, and yet be abſolutely air tight in the common engines; a ſtream of water is kept always running upon the piſton, which prevents the entry of the air; but this mode of ſecuring the piſton, though not hurtful in the common ones, would be highly prejudicial in the new engines. Their piſton is, therefore, made more accurately; and the outer cylinder having a lid which covers it, the ſteam is introduced above the piſton; and when a vacuum is produced under it, acts upon it by its elaſticity, as the atmo-

ſphere

fphere does upon common engines by its gravity. This way of working, effectually excludes the air from the inner cylinder, and gives the advantage of adding to the power, by increafing the elafticity of the fteam.

The internal ftructure of the new engines fo much refembles the common ones, that to thofe who know that machine, a drawing is fcarcely neceffary, and I expect they will underftand it from the following defcription.

The cylinder, the great beams, the pumps, &c. ftand in their ufual pofitions. The cylinder is fmaller than ufual in proportion to the load, and is very accurately bored. In the moft complete engines, it is furrounded at a fmall diftance with another cylinder, furnifhed with a bottom and a lid. The interftice between the cylinders, communicates with the boiler by a large pipe, open at both ends; fo that it is always filled with fteam, and thereby maintains the inner cylinder always of the fame heat with the fteam, and prevents any condenfation within it, which would be more detrimental than an equal condenfation in the outer one.

The inner cylinder has a bottom and pifton, as ufual; and as it does not reach up quite to the lid of the outer cylinder, the fteam in the interftice has always free accefs to the upper fide of the pifton. The lid of the outer cylinder, has a hole in its middle; and the pifton rod, which is made truly cylindrical, moves up and down through that hole, which is kept fteam tight by a collar of oakum fcrewed down upon it.

At the bottom of the inner cylinder, there are two regulating valves, one of which admits the fteam to pafs from the interftice into the inner cylinder below the pifton, or fhuts it out at pleafure; the other opens or fhuts the end of a pipe, which leads to the condenfer. The condenfer confifts of one or more pumps furnifhed with clacks and buckets, (nearly the fame as in common pumps) which are wrought by chains faftened to the great working beam of the engine. The pipe, which comes from the cylinder, is joined to the bottom of thefe pumps, and the whole condenfer ftands immerfed in a ciftern of cold water fupplied by the engine. The place of this ciftern is either within the houfe under the floor, between the cylinder and the lever wall; or without the houfe, between that wall and the engine fhaft; as conveniency may require.

The

The condenfer being exhaufted of air by blowing, and both the cylinders being filled with fteam, the regulating valve which admits the fteam into the inner cylinder is fhut, and the other regulator which communicates with the condenfer is opened, and the fteam rufhes into the vacuum of the condenfer with violence; but there it comes into contact with the cold fides of the pipe and pumps, and meets a jet of cold water which was opened at the fame time with the exhauftion regulator; thefe inftantly deprive it of its heat, and reduce it to water; and the vacuum remaining perfect, more fteam continues to rufh in, and be condenfed until the inner cylinder is exhaufted. Then the fteam which is above the pifton, ceafing to be counteracted by that which was below it, acts upon the pifton with its whole elafticity, and forces it to defcend to the bottom of the cylinder, and fo raifes the buckets of the pumps which are hung to the other end of the beam. The exhauftion regulator is now fhut, and the fteam one opened again, which by letting in the fteam allows the pifton to be pulled up by the fuperior weight of the pump rods; and fo the engine is ready for another ftroke.

The working of thefe engines is more regular and fteady than the common ones, and from what has been faid, their other advantages are apparently very confiderable; but to fay exactly how much they excel common engines, is difficult, as common engines differ very much among themfelves. I am told, that the favings amount at leaft to two-thirds of the fuel, which is a very confiderable object where coals are as expenfive as they are in Cornwall.

The new engines will raife from twenty thoufand to twenty-four thoufand cubick feet of water to twenty-four feet high, by one hundred weight of good pit-coal: and I am informed, that Mr. Watt's improvements do not reft here; for he means foon to exhibit to the world engines upon the fame principles, though differing fomewhat in conftruction, which will ufe much lefs fuel than thofe defcribed, and will alfo be more convenient for the purpofes of Mining, than any kind of engine yet ufed.

He has alfo contrived a kind of mill wheel, which turns round by the powers of fteam exerted within it; but as he has not made its ftructure publick, I cannot favour my readers with a defcription of it.

It

It may not be unacceptable to give a ſhort hiſtory of the invention. Theſe improvements were invented by Mr. James Watt, at Glaſgow in Scotland, in 1764. He obtained his Majeſty's letters patent for the ſole uſe of his invention in 1768, and then made a larger machine than what he had formerly tried his experiments upon; but ſeveral mechanical difficulties occurring in the execution of the machine, and his attention being engaged in other buſineſs, he laid aſide the undertaking until 1774, when he came to Birmingham, and in conjunction with Mr. Boulton, of Soho near that place, he completed both a reciprocating and a rotative or wheel engine. He then applied to parliament for a prolongation of the term of his patent, which was granted by an act paſſed in 1775. Since that time the buſineſs has been carried on by Mr. Boulton and him in partnerſhip.

They have erected ſeveral engines in Staffordſhire, Shropſhire, and Warwickſhire, and one ſmall one near London. They have alſo lately finiſhed another at Hawkeſbury colliery near Coventry, which is juſtly ſuppoſed to be the moſt powerful engine in England. It has a cylinder fifty-eight inches diameter, which works a pump fourteen inches diameter ſixty-five fathoms high, and makes regularly twelve ſtrokes of eight feet long each in a minute. They are alſo now erecting three engines more in Cornwall, viz. at Ting Tang, Owanvean, and Tregurtha Downs: and have lately ſet to work a ſmall engine at Huel-Buſſy Mine, which has a cylinder thirty inches diameter, that works a pump of ſix inches and a half diameter in two ſhafts by flat rods with great friction, three hundred feet diſtant from each other, forty-five fathoms high in each ſhaft, equal in all to ninety fathoms, and can make fourteen ſtrokes of eight feet long in a minute, with a conſumption of coal leſs than twenty buſhels in twenty-four hours.

The terms they offer to the publick are, to take, in lieu of all profits, one-third part of the annual ſavings in fuel, which their engine makes when compared with a common engine of the ſame dimenſions in the neighbourhood. The engines are built at the expence of the uſers, and Meſſrs. Boulton and Watt furniſh ſuch drawings, directions, and attendance, as may be neceſſary to enable a reſident engineer to complete the machine.

A N

E X P L A N A T I O N

OF THE

CORNU-TECHNICAL TERMS AND IDIOMS

OF

T I N N E R S,

Including thofe which are ufed in the Lead-Mines and Collieries of Great-Britain.

A

ACCOMPT. Account, or Account-day—Either a monthly or any other day of meeting of the Mine-Adventurers; when they affemble together to adjuft the charges of working the Mine, the particulars whereof are entered in a book called the Accompt-Book. The houfe of meeting, if on the Mine, is called the Accompt-Houfe.

Adit, Tye, or Level. A Sough in the north of England. An Adit, quafi, ab aditu ad aquas. (Carew's Survey). An Adit is a Conduit or Channel, begun on a valley or low ground at a diftance from the Mine, and thence continued at the fame depth or level home to the Mine, to cut in depth and drain off the water. Sometimes it may be brought home for the purpofe before mentioned acrofs the country, and at other times on the courfe of a Lode to prove it as they go. And at other times, for the greater eafe and fpeed on the courfe of a Crofs-Lode, Goffan, or branch, according as circumftances are favourable.

Adit-End. The furthermoft end or part of an Adit from its beginning, or the very place where the Miners are working under-ground towards the Mine.

Adventure. A Mine in working is fo called, and fo is the affair of being concerned in a Mine, as it is ufual to fay, "A perfon is about to take up an Ad-"venture."

Adventurers—Are thofe perfons concerned in a Mine who have Doles, fhares, or parts thereof. Out-Adventurers are thofe who contribute their quotas of the charge, but do not give a daily attendance. But In-Adventurers are fuch who have Doles, and alfo work in or attend the affairs of the Mine for wages, or pay their coft by account for goods.

After-Leavings. See Loobs.

Air-Pipe. A wooden pipe or tube, one end of which is above-ground, and the other end reaches down to the bottom of the Shaft, fo that the motion of the wind forces down air to the labourers.

Alive. That part of the Lode which contains Tin, Copper, or Lead, and is worth the faving and dreffing for the furnace, in oppofition to that part of the Lode which is dead or barren, and holds no Metal.

Anvil. Cornifh Anvon. A hard ftone or any other thing on which they fpal or break up the large ftones of Ore for the better feparation of their different kinds.

Arch, or Pillar. A piece of the Lode or Country left ftanding up to fupport the Mine; the Arch being a Drift or hole broke through the pillar.

Assay and Assaying. The product in Metal of one ounce of Tin or Copper Ore, or the procefs for knowing the product of any other Metal or Mineral.

Astel. A board or plank. (Lhuyd).—Stull—An arch or ceiling of boards over the mens heads in a Mine, to fave them from the falling ftones, rocks, or fcales of the Lode or its walls. To "throw the Deads to Stulls," is to throw the refufe part of the Mine on thefe arches or Stulls, both to fave the trouble of bringing it up to grafs, and becaufe this helps to make the Mine the more fecure.—Stidalls. In Du Cange's Gloffary of Latin Words, Aftulla, or Haftulla, Haſtulla, ſignifies a chip or ſegment of wood cut off from a greater piece. (Vid. Pref. p. 15. Leland's Itinerary, vol. vii. 1769). Stull, a Bunding in Derbyſhire.

Assistants. The commons or lower houſe of convocation or parliament of Tinners. Each Convocator appoints his own Aſſiſtant, who is generally ſuppoſed to be a gentleman of veracity, integrity, and underſtanding in all Mining affairs. There are twenty-four Convocators, and twenty-four Aſſiſtants every convocation. See Stannaries.

Astyllen. A ſmall ward or ſtoppage on purpoſe in an Adit or Mine to prevent the free and full paſſage of the water, by damming it up to a certain height, though not entirely to ſtop its current. Alſo, a kind of hedge or rude wall-work to ſeparate Lode and Deads from each other when brought to graſs. Alſo, a hedge under-ground, as a wall to prevent the running of Deads.

Attal, Attle, Adall, Addle. Corrupt, impure, of no value, off-caſts, Deads, or refuſe parts of the working that the Miners find under-ground on reaſſuming an old Adventure; that earth alſo which moulders away and falls down to the bottom of the Shaft, or pit, is called Attal, and ſo is all the ſtony earth broke in Mining which is not of a veiny nature. (Waſtrey or Deads in Derbyſhire).

Attall-Sarazen. Saxons or Jews off-caſt. (Carew's Survey).

Axletree. A thick piece of timber in form of a cylinder with a large rope wound about it, and with which they bring up the work or Ore, and uſually let the men deſcend and come up; but the windlaſs includes the axletree with its appurtenances, as layers, upſtanders, ſtays, and brace boards — Defined — Stows in the north of England, which are ſeven pieces of wood (ſet up on the ſuperficies of the earth) faſtened together by pins of wood. Two are called Soul-trees; two Stow-blades; two Hang-benches; and a Spindle; theſe Stows give a Miner, or any perſon who owns them, as good right to a meer or meers of ground (ſo that every meer has a pair of Stows ſet on them) as a deed of conveyance doth to any purchaſer.

B

Back—Of the Lode. That part of the Lode which is neareſt and uppermoſt towards the graſs or ſurface. (The Roof, Derbyſhire).

Bal. A ſhovel, a plague, a place of digging; Balas, To dig—Palas, idem. (Borl. Vocab.) When many people are employed in a Mine of note, in ſpaling, and ſorting the Ore, where it is brought to graſs, then they ſtile this place where the concourſe of people meet and work, by the name of the Bal, eſpecially if the place be ſeated on an eminence, for they ſay, "A perſon is "gone up to Bal;" but if the place or Mine lies low, it is uſual to ſay, "He "is gone to Moor;" if in the valley, they ſay, "He is gone to Coomb." Baly, ſignifies, To caſt up.

Bar. Any courſe or vein which runs acroſs a Lode or Mine is often termed a Bar; but they ſometimes meet with a very hard kind of ſtone, called an Ire-ſtone, which forms a ſort of courſe like as it were a Lode, but perhaps ſeveral fathoms wider: this is named a Bar. Bar-Maſter among the Lead Miners, is he which keepeth the Gage or diſh to meaſure the Miners Ore, he or his ſervant being preſent when meaſured. (Houghton's Rara Avis, &c.)

Bargain. See Fathom.

Batch. A parcel or quantity of any thing. "A Batch of Tin"—"A Batch "of Bread," &c.

Beat—"away the ground." Signifying the working away on the courſe of the Lode: or the ſtopeing away any ground in a Mine.

Beu. Alive. (Corniſh).

Beu-heyl. A live ſtream, i. e. rich for Tin.

Binder—Or Timber-man, ſo called, who undertakes to bind and keep a Mine open, or prevent any part from cruſhing or falling together.

Bing. See Cobb.

Black-Jack. See Mock-Lead.

Black-Tin. Tin Ore, triturated, waſhed, and clean for ſmelting.

Block-Tin or White-Tin. Is Tin brought to its fineſt purity by ſmelting.

Blowers. The perſons that melt Stream Tin with charcoal fires, excited by bellows worked by water wheels.

Blowing-House. The houſe wherein the furnace for blowing is. (Blaſt-Houſe in Derbyſhire).

Borier. An inſtrument of iron ſteel-pointed to bore holes with in large rocks, in order to blow them with gunpowder.

Bottoms. The deepeſt working parts of a Mine that is wrought either by ſtope-ing,

ing, driving, or otherwiſe breaking the Lode. (Bottom, Sole, in Derbyſhire).

BOTTOM-CAPTAIN. A ſuperintendant over the Miners in the Bottoms.

BOTTOMS—in Fork. When all the Bottoms are unwatered, they ſay, "The "Bottoms are in fork;" and to draw out the water from them, or any Dippa, or any other particular part of a Mine, is ſaid to be "forking the water;" and when accompliſhed, "Such Dippa, &c. "is in fork." Likewiſe when an engine has drawn out all the water, they ſay, "The engine is in fork."

BOTTOM-LIFT. The deepeſt or bottom tier of pumps.

BOUNDS and BOUNDERS. Are limited parcels or pieces of land enjoyed by the owners of ſuch Bounds. See book iii. chap. iii. page 137.

BRACE. Includes the ſpot of ground where the chief working Shaft of the Mine is, with the materials and implements thereunto belonging, as axletree, rope, &c. See AXLETREE.

LAY DOWN AT THE BRACE. If a perſon is deſirous of relinquiſhing his Dole in a Tin Mine, he does ſo either by writing in the account-book, after having paid his coſt to that time; or elſe he lays down, or declines his Dole at the Brace, by putting his hand on the axletree, and publickly declaring that he will be no longer concerned in the Mine.

This was an ancient cuſtom, but it was obſerved only in Tin Mines; and how far it is lawful ſo to do, or binding upon the reſt of the concerned, is matter of doubt.

BRANCH. A leader, ſtring, or rib of Ore, that runs in a Lode; or if a Lode is divided into ſeveral ſtrings, they are called Branches, whether they contain Ore or not: likewiſe ſtrings of Ore which come tranſverſely into the Lode are called Branches, and ſo are all veins that are very ſmall, dead or alive, i. e. whether they contain Ore or not.

BROOD. Any heterogeneous mixture among Tin or Copper Ore, as Mundick, Black-Jack, &c.

BRYLE. See page 125.

BUCKING and BUCKED ORE. A method of breaking the poor foul Copper Ore ſmaller by hand with ſmall flat irons, called Bucking-Irons, in order to waſh and ſeparate the pure Ore from the uſeleſs waſte. The ſame term is uſed in the Lead Mines. But Pettus, in his Fleta Minor, gives it the ſignification of waſhing, or wet ſtamping Ores.

BUDDLE. Pits dug in the earth near the ſtamping mill, ſeven feet long, three feet wide, and two and a half feet deep, where the ſtamped Tin is curiouſly waſhed from its impurities by water conſtantly running through the Buddle, while a boy, called a Buddle-boy, is ſtanding in the body of it, and working both with a ſhovel and with his feet.

BUNDING. See ASTEL.

BUNNY—Of Tin or Copper Ore. A Sombrero in Alonzo Barba. A pipe of Ore. A great collection of Ore without any vein coming into or going from it.

BUNCH or BUNCHY. A Mine that is ſometimes rich, and at other times poor, is ſaid to be bunchy. We alſo ſay a rich Bunch of Ore; and if it is ſhort, we ſay it is a Bunch.

BURDEN. The top, waſte, or deads in ſtream works, that lie over or upon the ſtream Tin, which muſt be cleared away before they can work effectually. All waſte covering of Tin, &c. which muſt firſt be removed, is called the Over-burden, Top-burden, or the Burden.

BURROW. That heap, or heaps of attle, deads, or earth (void of Ore) which are riſen out of a Mine, and commonly lie around the Shafts. Any heap or hillock of deads or waſte.

C

CAPLE. A ſort of Stone ſomething like a Limeſtone, but will not burn. The walls of moſt Lodes are of this kind of Stone, therefore it is common to call the wall of a Lode, by the name of its Caple. Alſo ſome veins which abound with this Stone, are termed Caples, or Caple Lodes.

CAL. (It ſignifies in Corniſh, Cunning, Lean). Properly, Gal. A kind of Iron Goſſan Stone found in the Bryle and backs of Lodes, much of the colour of old Iron, reckoned a poor brood with Tin; therefore it may be ſo applied becauſe it impoveriſhes the Lode and deſtroys the fatneſs of the Metal. (See Gal). It is termed Wolfram by Cronſtedt, and defined a kind of Manganeſe.

CALK. Corniſh, for Lime.

CALLYS. (Cals, Caliſh, Cales, ac idem, Callys,) Killas. (Corniſh) Hard; ſmart. The moſt common and agreeable Stratum in our Mine country, uſually called Killas, (Killow, by Woodward). Of the many ſorts of this Stratum, ſee book i. chap. i. I believe this

this to be the proper name for Killas, as it means a hard firm Stone.

Captain. An experienced Miner, who directs and overfees the workmen and bufinefs of the Mine.

Carn. A rock. A heap of rocks. A high rock. The ftony Stratum.

Cased Tin. That which is reframed by the gentleft current of water, and prevented from running off the frame by turf placed at the bottom.

Cases. Probably a corruption of Chafm. Very fmall fiffures in the ftrata of the earth, through which fmall ftreams of water flow when they are opened by working under-ground, greatly to the hinderance of the workmen, &c.

Cast after Cast. Is throwing up of Tin-ftuff, &c. from one ftage of boards to another, each caft about five or fix feet high.

Cast of the Country. See Country.

Casualties. See Leavings.

Caunter and Caunting. Contra. When two Lodes run acrofs, the one, or either of them, with refpect to the other, is called a Caunter or Contra, for they run caunting, or contra-ing each other. As all Lodes which run cardinally eaft and weft, go through every kind of vein except Crofs-Goffans, I define fuch to be Caunters.

Charge. Any quantity of Ore put at one time into a furnace to fufe, they call a Charge. Letting it out, they call "Tapping the Charge."

Choak. An Adit is faid to be choaked when any earth or ftone falls in and prevents the current of the water through it. The place or part fo filled, they call "The Choak."

Clack. The valve of the pump pifton. The Can-lead, in Derbyfhire.

Clack-Door. A fquare iron plate fcrewed on to the fide of a bottom pump or fmall bore, for convenience of changing the Clack, or valve.

Clearing—The Deads, Clearing a Shaft or Drift, &c. When any part of a Mine or Drift is filled or incommoded by Attle or Deads, the removal of fuch is called "Clearing the Deads," "Clearing of Attle," or the like. In old workings it is the firft thing to be done, and in the north they term it, "Clearing the old man."

Cob. (Dho Cob, Cornifh). To break or bruife. A Cobber, a bruifer of Tin. Cobbed Ore is the fpalled which is broke out of the folid large ftones with fledges, and not put to water, being ufually the beft of the Ore; the fame as Bing Ore in the Lead Mines. Nocking, Derbyfhire.

Cockle. The Skiorl of the Swedes, and the Schorl of the Germans. Anglicè, Shirl, (Cronftedt). A laminated Mineral fubftance of a blackifh brown colour like Tin, often intermixed with it, and taken for it, to the frequent detriment and difappointment of the Tinners. Cockle is a Weed in Cornifh; whence, a Weed or Brood in Tin. See Pope's Gloffary to Shakfpeare.

Côfer. (Côfar or Kopher, Cornifh, a Cheft). A fmall wood trough under the frame, which receives the Tin cleared from its impurities or flime.

Coffin. Old workings which were all worked open to grafs, without any Shafts, by virtue of digging and cafting up the Tin-ftuff from one ftage of boards to another. Workings all open like an intrenchment.

Coke. Charked pit-coal.

Collar—"of a Shaft," is the timber and boards which fecure the uppermoft part of a Shaft in the loofe rubble from falling in.

Coomb. See Bal.

Convocation and Convocators, or Parliament of Tinners. All ftannary laws are enacted by the feveral convocations, and carry with them all the force and law of acts of parliament. A Convocation is but too feldom held, to the difgrace of the county and the injury of the Tinner; for the laws now in being are very weak, contradictory, and inconclufive. See Assistants and Stannaries.

Core. (i. e. Corps; body, company, fociety. French. Boyer's Dict.) Corps is ufed among the military, and pronounced Core. With the Tinners it has alfo a refpect to time, fuch as their proper change or turn of working. Thus it is faid, the firft Core by night is eight o' clock, for inftance; the fecond Core is four after midnight, and the day Core commences perhaps at noon-day, according as the labourers will fettle among themfelves. But in difficult and hard working places, where water is too troublefome, or air is very deficient, they divide their Cores into four; that is, every fix hours. In fuch cafe, they relieve upon the fpot; for at the known hour, frefh men come underground, and take the tools from them who have juft finifhed their working time. See Day-Pair.

Costean.

Costean. (From Cothas, to find; Stean, Tin; or Dropt-Tin. Cornifh). Coftean pits, are fhallow pits to trace or find Tin. Cofteaning, ditto.

Count-House. (Reckoning-Houfe, in Derbyfhire). A houfe or room on the Mine, wherein the Adventurers and their agents tranfact the bufinefs and keep the accompts of the Mine. See Accompt.

Country. The Strata of the earth. When Miners drive an Adit out of the Lode or vein in the folid Strata, they fay, "They are driving in the Coun-"try;" fo if they fink a Shaft to cut a Lode, they are faid to be finking in the Country until they come to the Lode. Likewife, an Adit or Drift which is driving north or fouth, is "acrofs the Country." Alfo, the fimilarity of the Strata for fome continuance, is denominated "The run of the "Country" and "the eaft of the Coun-"try."

Course. Any vein or Lode is often termed a Courfe. A Tin-Courfe. A Copper-Courfe. A Crofs-Courfe. And the phrafe of "Working on the Courfe "of the Lode," implies to work along on its direction or length; but when it is faid, "A Mine is in full Courfe of "working," the meaning is, that it is fully occupied; fo, likewife, when it is faid, "The men keep a due Courfe "of working," it fignifies, they duly mind their labour.

Creazes. The work or Tin in the middle part of the Buddle in dreffing, viz. the head or fore part of the Buddle, the Creaze or middle, and the tail or laft, though fome call that the Hind-Creazes.

Crop. Ore or Tin of the firft quality after it is dreffed or cleanfed for fmelting. The fineft black Tin is called the Crop, worth, at a medium, one for two; i. e. forty pounds of fuch black Tin you may exchange for twenty pounds of Block-Tin, called White Tin. The fecond fort is called Rows, a corruption of Roughs, being poorer and larger in fize; faleable at fix for twenty.

Cross. Crofs-Courfe. (See Bar, Course). Crofs-Bar; Crofs-Goffan; Crofs-Lode. Is either a vein of a metallick nature, a Crofs-Goffan, or elfe a foft earth, clay, or Flookan like a vein, which unheads and interfects the true Lode. (A crofs vein in Derbyfhire).

Cuare. (Cornifh) A quarry of ftones.

Cut. To interfect a vein, branch, or Lode, by driving horizontally or finking perpendicularly at right angles. "I cut "the Lode at twenty fathoms depth." "I cut the north branch in driving ten "fathoms." "We cut a large ftream "of water in the Adit-end."

D

Damp. (Dampff, Teutonick). A vapour, or pernicious Halitus, from or in the bowels of the earth. A want of circulation of air under-ground.

Day. Ore is faid to be difcovered near the Day, when it is found near the furface.

Day-Pair. Are thofe who work underground by day; and Night-Pair, vice verfa. See Core.

Deads. Any thing that is broken underground unmetallick, or not worth the faving; in oppofition to that part of a Lode which is rich for Metal: therefore Lodes which are unmetallick, are called Dead Lodes.

Derrick. (Cornifh) A Sexton, a Digger, a Miner. (Nomen Familiæ).

Dialling. Is the method of taking a traverfe under-ground by the compafs, fo that by laying out the fame aboveground, they find where an Adit-end is; or the end of any other drift or working, in order to fink a new Shaft on it perpendicularly. Alfo, by Dialling they find the juft limits of their ground underneath, to know if it correfponds with their limits above, &c.

Dillueing. (Dilleugh, To let go, let fly, fend away. Dylyr id. Cornifh). A method of wafhing or finifhing the dreffing of Tin in very fine hair fieves, called Dillueing fieves or Dilluers.

Dippa. (A pit, Cornifh). A pit or hole funk in a Lode by way of a little fumph to collect water to draw out by fmall barrels; alfo a pit funk in a bunch of Ore, which is a very irregular and ruinous way of working a Mine. The Tinners fay, "It is eating the calf out "of the cow's belly."

Dish. That part of the Ore or fterling poundage, which the Lord or owner of the fee referves to himfelf, free of all charges, in confideration of the liberty he grants the Adventurers to dig and fearch for Metals, or occupy the Mine. The Difh is alfo ftiled the Lord's Dues, (See Bounds, Farm, Sett, and Toll). In the Lead Mines, a Difh is a trough of wood twenty-eight inches long, four deep, and fix wide, by which they meafure that part of the Ore which is called

called the Lord's Lot—and, no doubt, this was the method formerly uſed in Cornwall, from whence the Lord's Diſh is a term now in uſe.

Diſh is the ancient name of a meaſure uſed for black Tin, containing a gallon. (Carew). "Diſhes or bowls are meaſures filled with Ore by the Miners, whereof, ſome are paid to the king, others to the church," &c. (See Pettus, on the word Metallick).

Dizzue. (From Dyz-hui, to diſcover unto, Corniſh). To Dizzue the Lode, is this: If it is very ſmall and rich, they commonly only break down the country or ſtratum on one ſide of it, by which the Lode is laid bare, and may be afterwards taken down clean and free from waſte. To Dizzue the leader of a Lode is much the ſame thing; for if there is a ſide or part of the Lode better than the reſt, but not a Working Big, they keep the beſt part ſeparate and let it ſtand in its place, until they firſt break and remove the poor part; afterwards they break the Dizzue or beſt part, and reſerve it to be ſeparately handled and dreſſed: thus the good Ore is dreſſed with leſs charge, and proves better in value than if it were promiſcuouſly with the poor Ore. (See Hulk). The refuſe or deads of a Dyzhued Lode, is called in ſome places, "The Dyzha."

Doar. (Corniſh. The earth. An Oar, idem) Whence Ore, the earth of Metals.

Dôl. (Iriſh, Daal; Saxon, Deald, divided, ſee Verſtegan; Corniſh Dôl.) Any part or ſhare of the Adventure or Tin Ore, as one-eighth, one-ſixteenth, one-thirty-ſecond, or the like. "Anciently where a meadow was divided into ſeveral ſhares, it was called a Dôl-meadow." Jacob's Law Dictionary.

Dol. Pronounced Doll, is Corniſh for a valley or dale. Dol-côth, the old field or meadow. Dol-côth, the old valley or dale. The name of a great Mine in Camborne, Cornwall.

Double-Pick, Double-Men. Is when two men are allowed to attend one pick-axe by day, and as many by night, if needful, ſo that the pick is kept conſtantly at work.

Dredged—Ore. See Powdered-Ore.

Dresser. Any perſon who ſuperintends the boys at ſtamping mills; or men, boys, and girls in the Copper Bals, commonly called Pickers, Cobbers, and Jiggers. The man that directs the various manuductions and lotions of Ore for ſale, is called the Dreſſer.

Drift. Is the level that the men drive under-ground from one Shaft to another, from one Winds to another, or north and ſouth out of the Lode, in which, only one man at a time can work, it being but a working big, and about five or ſix feet high. In the northern counties this is called a Gate; a Way-gate; a Waggon-gate.

Driggoe or Drigger. The lower pump of the ſet or tier of pumps belonging to a water engine. See Tier.

Drive. To drive is to work in a Drift, ſo that if you drive or work on ſtraight in a Lode or in the country, the vacant paſſage behind your back is the Drift. To cut, in Derbyſhire. See Drift, ſee Cut.

Dry. See Vat.

Dues. See Dish.

Dumb'd. When Tin or Copper Ore is ſtamped under ſize or too ſmall, it is apt to choak the grate, or flow away with the water in dreſſing, then they ſay, "It is Dumb'd."

Durgy. A ſmall low hedge of turf. Any thing low or ſhort. "A Durgy-man or woman."

Durns. Frames of wood like the jambs of a door or the frame of a window, commonly ſet in looſe ground in Adits and places that are weak and liable to fall in or tumble down. (Forks and Sliders; Stop Rods and Grove Timbers, in Yorkſhire. Piers and Pairs, in Derbyſhire).

E

Elbow. A Lode makes an Elbow thus ^ when it is preſſed or ſqueezed by hard Strata or rocks which cauſe it to deviate from its true courſe or direction, making an obtuſe angle and ſmall turning, though ſeldom diſordered in any other reſpect.

Elvan. (Elven, in Corniſh, an element, a ſpark of fire). A very hard cloſe grained ſtone, thought to be a baſtard limeſtone; but I do not find that it has any calcarious quality. A very unpromiſing Stratum for Copper Ore.

End. An End is the furthermoſt end or part of an Adit, or any other Drift from its beginning, or the actual working part of a Drift or Adit. (A Stool and Forefield, in Derbyſhire. Forehead, in Yorkſhire).

Engine. A machine to unwater Mines. Thoſe which are worked by water, are termed Water-engines. Others which perform

perform their office by fire, are Fire-engines. There are other ſorts called Horſe-engines. The perſons who undertake to erect and take care of them, are called Engineers.

F

Farm. That part of the Lord's fee, which is taken for liberty to work in Tin Mines only, that are bounded, which is generally one fifteenth of the whole. See Bounds, Dish, Sett, Toll.

Fast. The firm rock or ſtone unmoved by the deluge, which lies immediately under the looſe rubble.

Fathom. Six feet in height, depth, or length. All work in the Corniſh Mines, is generally performed by the fathom; ſuch as ſtoping, driving, and ſinking.

Feasible-Ground; is Ground that can be ſpeedily wrought, and yet will ſtand without the ſupport of timber and boards.

Firm. Firm ſhelf. See Fast and Shelf.

Fissure or Gully; is that crack or ſplit in the Strata of the earth, which is the receptacle of mineral particles, whoſe contents are ſtiled a Lode.

Flats or Flat-Rods; are horizontal rods or poles fixed by a ſemicircular wheel to the perpendicular rods of a fire or water engine, by which the piſton in a pump at ſome diſtance from the engine draws water.

Flookan. An earth or clay of a ſlimy glutinous conſiſtence; in colour, for the moſt part, blue or white, or compounded of both. A Croſs-Flookan runs acroſs through a Lode, unheads it, and throws it on one ſide out of its place. There are Flookans alſo which run parallel with metallick Lodes, and take the name of Courſe-Flookans. Some metallick Lodes abound with a large part of this clay on either or both walls of the Lode; and when it is throughout the vein, it is called a Flookan Lode. A ſmall ſlide is alſo a fiſſure filled with clay or Flookan. See Slide.

Floor. A Floor is a bed of Ore in a Lode, though ſuppoſed not to continue to any great depth or time; therefore is a Stratum of Ore.

Floran. Is an exceeding ſmall grained Tin, ſcarce perceivable in the ſtone, though perhaps very rich. Alſo, any Tin which is ſtamped exceeding fine, and underſize, is called Floran Tin—quaſi, Flower Tin.

Foge. (Corniſh) A forge or blowing-houſe for ſmelting of Tin.

Foot. An ancient meaſure for black Tin, two gallons; now a nominal meaſure, but in weight 60 ℔.

Footway. In ſhallow Mines, the common way of going down is by a rope or windlaſs: but in deep Mines, they have old Shafts with ladders in them, and landing places at the foot of each ladder called a Saller, by means of which they deſcend into the Mines; whence this is ſtiled the Footway; and thoſe Shafts, when applicable to no other uſe, Footway Shafts. (Waygate and Climbing Shaft, North of England).

Forcer. A ſmall pump worked by hand, uſed in ſinking of ſmall Sumphs, Dippas, or Pits.

Forcque, Fork; the bottom of the Sumph. Forking the water, is drawing it all out; and when it is done, they ſay, "The "Mine or the water is Forked;" and "the Engine is in Fork." The Forcque or bottom of the Sumph in the North of England, is called the Lodge; Forking the water, "Rolling the water;" the Engine in Forcque, "the Engine in "rowl."

Frame or Rack; compoſed of two planes of boards a little inclined, over which runs a very ſmall equable ſtream of water to waſh off the ſordes from ſlime Tin, &c.

G

Gad. (Gedn is Corniſh for a wedge; Gad an iron wedge; Gad is Armoric for a Hare). A Gad is an iron wedge to drive between the joints of rocks, in order to looſen the ground for the pickaxe.

Gal. The proper name for Cal. Gal ſignifies ruſt and ruſty in Corniſh; and, accordingly, Gal, uſually pronounced Cal, is a Goſſany, or ruſty Iron Ore. Kal is a falſe word for it, that term ſignifying Phallus; Membrum Virile.

Gangway. When a Fiſſure or Lode is excavated in the backs or former upper workings of the Mine, it is fallered with boards, and the deads are thrown there, which they alſo call Stulls: however, if they leave room ſufficient for the workmen to roll ſtuff, or walk upon them from one Shaft to another, they call it a Gangway. Gang, in the Teutonick, ſignifies a Vein; but it is a ſea term alſo.

Gatchers. The after leavings of Tin. See Loobs.

Glist. A ſhining black or brown Mineral of an iron caſt, ſomewhat like Cockle.

Gossan. A kind of imperfect Iron Ore, commonly of a tender rotten ſubſtance, and red or ruſty iron colour. It is often found ſhallow in Tin, Copper, and Lead Mines, and is the proper Nidus or Matrix for the two latter. It is an upper covering to the Ore, levels above thirty fathoms, and is very abundant; whence thoſe Lodes are called Goſſan Lodes.

Gounce. See Streke, and the chapter on Stream Tin.

Grain Tin. The Ore of Tin that is ſometimes dug very rich in the form of grains or pebbles, or elſe in larger pieces, compoſed of many ſuch diſtinct grains, united in one entire maſs, always of a black or dark roſin colour, pointed like diamonds. Alſo, the pureſt and fineſt block or white Tin, ſmelted with charcoal in the blaſt or blowing-houſe furnace, which never had any brood or foreign mixture in the Mine. Grain Tin is peculiarly produced from ſtream work, and is worth ſeveral ſhillings ℘ ⊕ more than Mine Tin.

Grant. See Sett.

Grass, or at Graſs, ſignifies on the ſurface of the earth. "Is Tom Treviſcas "under-ground? No; he's at Graſs." A Graſs Captain is an Overſeer of the workmen above-ground, as the bottom or under-ground Captain ſuperintends his men down in the Mine.

Grate. An iron plate punched full of ſmall holes; which belongs to the ſtamping mill, and ſizes the ſtampt Ore, becauſe it muſt all paſs through theſe holes by a ſmall ſtream of water.

Greut or Grit. A kind of foſſil body, of ſandy rough, hard, earthy, particles.

Griddle. A large wire ſieve, uſed inſtead of a hurdle, for ſifting and ſorting of Copper Ore, as it riſes from the Mine. Erckern calls it a Ratter, or Riddle, Screen or Sieve, to ſeparate the clean from the unclean Ores before they come to the fire. "This inſtrument doth "unriddle them by ſeparation: and for "the word ſcreen, it is doubtleſs from "ſecernere to divide, and ſieve from "ſegregare or ſever." Pettus on the word metallick.

Grouan. (Grou, Corniſh) Gravel, rough ſand. Grouanen, a pebble. Hard Grouan is Granite or Moorſtone. (Gronſten, Swediſh) Soft Grouan is the ſame materials in a lax and ſandy ſtate. Grouan Lode, any Tin Lode which abounds with this gravel. Grouder, a mixture of Grouan and clay, much uſed for ſcouring of timber-ware in houſewifry.

Ground. (See Country, and Shut). We ſay, a hard rock or Stratum is "Hard Ground." On the contrary, ſoft clayey Ground they call "Fair "Ground;" and if fair, yet firm to ſtand without timber, "Feaſible "Ground."

Guag. (Hunger, emptineſs; ac idem, Leary, Corniſh). Tinners holeing into a place which has been wrought before, call it "Holeing in Guag."

Gulph of Ore. Where a Lode throws up very great quantities of Ore, and proves laſting and good in depth, they ſay, "They have a gulph of Ore."

Gunnies—means breadth or width. A ſingle Gunnies is three feet wide; a Gunnies and a half is four feet and a half; and a double Gunnies is ſix feet wide. The former vaults or cavities that were dug in a Mine, are termed "The old Gunnies;" and if they are full of water, they are ſometimes called "The Gunnies of water;" yet more commonly "A Houſe of water.

Gurt. A fret or channel made by great rain or floods in a highway; alſo, a channel to carry off water from one place to another for dreſſing of Copper Ore, Tin, or the like. Gurt, in Corniſh, implies large, great. "Gurt "Mawr of Vuſs," Great root of furze.

H

Halvans, Halvings, Hanaways. All which names imply the refuſe Ore, or the poor Ore and Stone after the prime Copper Ore or Crop is firſt taken out; but they often cull over theſe Halvans again, and take more Ore out of them, which is called Halvan Ore. (Halvans, waſte hillocks, North of England). The poor refuſe part of Tin-ſtuff goes not by this name, but that of Leavings, or Caſualties.

Heads. See Stamp-heads.

Heave. See plate of Heaves in Goonlaz, &c. and book ii. chap. iii.

Hewns. The ſides of a calciner or burning-houſe furnace, from their being formerly built with hewn Moorſtone.

Hoggan. In Corniſh ſignifies a Hawthornberry; alſo, any thing mean or vile: but here it means a Pork Paſty; and now indeed any Tinner's paſty that he carries

carries to Bal with him, is called a Hoggan.

HOLE. To hole, is to make a communication through one part of a Mine to another. To hole a Shaft, is to fink it through into the Mine or hollows.

HOOKHANDLES, are the handles of the turn or windlafs for winding up the work from underground. (The Sweeps, North of England.)

HORSE. A portion of dead ground in a Lode, which widens like a horfe's back from the fpine. (See plate of Bullen-Garden Mine, fig. 57.) A Rider and a Rither in Yorkfhire.)

HOUSE. See GUNNIES, and TURNHOUSE.

HUEL. A Work, a Mine; as Huel Stean, a Tin Mine: Huel Kalifh, the hard work.

HULK. An old excavated workings. "To "hulk the Lode," is this: when the Lode is very wide, and only one fide of it is rich for Copper or Tin, but much fofter and more fair than the other poor part of it, they hulk in with their picks as far as they can upon the rich tender Ore, and leave the hard unmetallick part of it to ftand by itfelf, which they afterwards blaft by gunpowder, or otherwife break down and throw away. See DIZZUE.

HURDLED ORE. That which is fized by paffing through a hurdle, like earth for mortar.

HYRLIAU. (Hurling, Cornifh). A Cornifh cuftom of playing with a ball. Hyrliau yu ghen guare wyi — Hurling is our fport. The ball is generally plated with Tin or Silver, and has ufually a Cornifh motto alluding to the play, as "Guare wheag, yw Guare teag; that is, Fair play, is good play."

I

JETTERS. See POKKERS and JETTERS. See FLATS.

JIGGING. Is a method of dreffing the fmaller Copper and Lead Ores by a peculiar motion of a wire fieve in a kieve or vat of water, where the fmalleft particles pafs through the Jigging-fieve, and thofe which are larger and folid lie at the bottom of the Jigging-fieve or Jigger; fo that the uppermoft light ftony wafte may be eafily feparated and fkimmed off by a piece of femicircular board, called a Limp. In the Lead Mines, the Jigged Ore goes by the name of Peafy; and they alfo term this operation, "Setting in the Sieve," and "Wafhing."

INFECTION. (A BROOD, which fee). Any heterogene Mineral mixed with Tin or Copper Ore.

IRESTONE. Takes not the name from its participation of Iron, though there is fome Iron in it, but from its exceffive hardnefs. Its colour is a bluifh grey, and fometimes it runs feveral miles, keeping its courfe on directly like a Lode. Being very difficult to work and break through, it is therefore often termed an Iron Bar, or a Bar.

K

KAL. (See CAL and GAL). Kal. A Phallus; Membrum Virile. Lhwyd. Kalifh, hard.

KAZER. A fieve.

KERNED. A heap of Mundick or Copper Ore will harden by lying expofed to the fun, when they fay it is kerned.

KERNOU. Cornwall. Kernuâk, Cornifh.

KIBBAL. (A bucket, a little tub. Armoric. Quibell, idem). A Kibbal is the bucket in which all work or Ore is raifed out of the Mines. Gear barrels, in the North of England. A Whym-Kibbal is a larger one, which belongs to the machine called a Whym, and ferves to draw water with, or bring up the Ore to grafs. Some of thofe larger barrels or Kibbals contain 120 gallons when they are intended for drawing of water out of the Mine.

KIEVE. A vat or large iron-bound tub for wafhing of Ores, &c.

KILLAS. (See CALLYS) Woodward fays, "We call any ftone Killas that fplits "with a grain," p. 6. Killas, plate, in Yorkfhire, &c.

KIVULLY. Loofe, hollow, fhelfy ground.

KNOCKING. See COB.

L

LANDING-PLACE; the place where they caft the work out of the Kibbal, contiguous to the working Shaft, which they alfo term the Landing Shaft, being a Whym Shaft.

LAPPIOR. (Cornifh). A dancer. See book iii. chap. ii. pag. 136.

LATHS. Are deal boards pointed at one end, for driving betwen durns or frames of timber and loofe deads, in that manœuvre called "Shutting of attle;" they are called Laths, from fome refemblance to laths for plaiftering.

LAUNDERS. Troughs of deal boards to fave the water, and prevent its falling down

down into the bottoms; alfo, to convey water acrofs Shafts, Drifts, and Gunnies, and for conveyance to any place for driving engine or mill wheels.

Layer—and laying of Tin. See Serving.

Leader. A branch, rib, or ftring of Ore, that leads along to the Lode; or elfe if it be in the vein, and points, or leads away, fo that they hope for a parcel or bed of Ore by following it, then this ftring is a Leader or Guide; moreover when they purpofely drive on, and follow veiny natured ftrings, though without any Ore or life in them, yet fuch are Leaders to follow. See Lode.

Learys—or lear; emptinefs. Old men's workings. Vide Gloffary Pope's Shakefpeare.

Leat. A water courfe, or level for conveyance of water, to engine or mill wheels.

Leavings—or Cafualties, in Tin, is the fame as hanaways of Copper or Lead Ores, both being gleanings: but it rather implies the very minute Tin, that flows away with the water, in dreffing the crop or prime Tin; but being gathered together is redreffed to cleanfe it from its impurities and flime, &c.

Levelling — and Levels. The art of finding a true Level to convey water from one place to another, or elfe to find the Level or depth of an Adit at a prefixed place.

Life—ac idem, Alive; which fee.

Lifters—are folid pieces of afh timber 8 or 9 feet high, fhod with iron ftamp-heads for pounding the Tin-ftuff, &c.

Little-Winds. (A fump in fome parts of England) An under-ground Shaft, funk from a horizontal drift, by which the top of the Winds communicates with the fide or bottom of the grafs working Shaft.

Liver—or ly-very ftone. A hard liver-coloured ftone, and in a Lode is very hurtful.

Lode. (Main Rake, N. England) The word Lode is an old Anglo-Saxon word, idem ac, Lead; fo Lode-ftone, quafi Lead-ftone: fee Lye's edition of Junius ad verbum. Any regular vein or courfe, either metallick or not; but more commonly it means a metallick vein: and being occupied and proving good, may indifferently be called a Lode, Mine, or Work.

Lode-Plot. A Lode that underlies very faft or horizontal, and may be rather called a Flat Lode.

Lofty Tin—in contradiftinction to Floran Tin, for Lofty Tin is richer, maffive, and rougher, and not fo weak or imperceptible in the ftone, or in powder on the fhovel.

Loobs. Tin flime or fludge of the after leavings, or leavings flime.

Lord of the Land or Fee. The perfon in whofe land the Mine is; therefore, the part which he referves to himfelf for liberty to work a Mine in his land, is the one-fixth, one-feventh, one-eighth, or any other proportion free of expence, and called the Dues, Difh, which fee.

Lost-Slovan. (Loft, a tail, a rump, Cornifh) Vulgo, Low-flovan; the beginning of an Adit, though the tail or end; that part which lies open like a trench, before they drive under-ground.

M

Mad-Water. Water that has been drawn from a Shaft, or any part of a Mine, and returns back again to the fame place from whence it was drawn, is called Mad-Water, and implies a great want of fkill in the managers.

Materials. All tools and tackle, timber and implements, that belong to a Mine; and in large Mines a perfon is appointed to take care of them, who is called the Material-Man.

Meat-Earth—Soil; the fuperficial earth, fit for agriculture.

Mock-Lead. Wild Lead, black Lead, black Jack. A ponderous black Mineral, which does not readily incorporate in the fire. A Zinc Ore.

Moor. (See Bal) This wood fignifies a root, or a quantity of Ore in a particular part of the Lode; as "A Moor "of Ore." "A Moor of Tin."

Moorhouse. A hovel built with turf for workmen to change cloaths in. A Coe, Derby.

Moorstone. See Grouan.

Mun. Any fufible Metal; unde Dunmwyn, a hill of Metals; unde Dunmonii, the Cornifh Britains.

Mundick. An exceeding ponderous Mineral, whitifh, beautiful, and fhining, but brittle. Pyrites; Marcafite, &c. too well known for defcription here.

N

Needle. A piece of ftout iron wire, ufed to make a touch-hole with in blowing of rocks with gunpowder. A pricker, Yorkfhire.

Night-Pair. See Day-Pair, and Core.

Nocking. Knocking. See Cob.

Old

O

Old Men's Workings. See Learys.
Ore. Earth. (See Doar) Round Ore; rough, or Row Ore; ftraked, ftamped, bucked, jigged, and flime Ores; which fee.
Ore-Plot. (See Plot) The Ore Plots at grafs; where they keep apart the dreffed Ore for fampling, &c.
Owners. See Adventurers.

P

Packing. A further or final dreffing of Tin or Copper Ore, by putting of either in a kieve or vat with water, often ftirring the water, and ftriking the fides of the kieve, by which means the heavy particles fink to the bottom, and the light wafte fwims uppermoft; which is afterwards fkimmed off, and thence called the Skimpings; which fee.
Pair. Any indeterminate number of Miners who work together in a Mine in a Pitch upon Tribute, in a But-Bargain, &c. Alfo, they call any number of horfes, from five to twenty, a pair of horfes. See Core and Day-Pair.
Parcel. A parcel of Ore, is a pile or heap of Copper dreffed for fale.
Peach. Peach-Stone, a bluifh green foft Stone. When a Lode is moftly compofed of this fort of Stone, it is called a Peach or Peachy-Lode.
Pednan. Pedn or Pen. (Cornifh). A head or promontory. In Mine affairs, the Pednan is the head of the buddle where Tin is dreffed.
Pick. The common name of a Tinner's pick-axe; alfo, to pick or cull the good Ore from the bad by hand; whence thofe who do it, are called Pickers.
Pile—Of Ore. A heap of Ore; a parcel of Ore; and fometimes a Dole of Ore.
Pillar. An upright piece or part of the Lode left to fupport the incumbent weight.
Pillion. The Tin which remains in the fcoria or flags after it is firft fmelted, which muft be feparated and remelted.
Pioneer. An able Pickman or underground Tinner.
Pipe. See Bunny.
Pit. A Shaft, Dippa, Sumph, or Coftean Pit; all Pits of different depths.
Pitch. Any part or portion of a Mine, being a few fathoms in length on the courfe of the Lode, is fo called: and if granted to the Miners for raifing the Ore at fo much out of the pound fterling, it is called, "A Pitch upon Tribute;" if it is higher up in the Mine at a fhallow level, it is called, "A Pitch upon the Backs;" and lower down, "A Bottom Pitch."
Plot. (Vulgo, Plat). "To cut a Plot," is to make room, or fquare out a piece of ground by the fide of the Lode or Shaft, for holding the broken work or deads before they are brought to grafs; or for other convenient purpofes. (A Plot, a Brigging-place in Derbyfhire).
Plump. A corruption of the word Pump.
Podar. Rotten, corrupt; Mundick—Copper Ore was formerly called Podar.
Pokkers and Jetters. Are blocks or pullies, over which the fweep rods of fome engines move and play. (See Flats). Pokkia (Corn.) unde Pokker, to thruft, poke.
Pol-Rôz. (Pol, a pool; Rôz, a wheel, Cornifh). The pit under a mill-wheel; the wheel-pit.
Pol-Stean. (Pol, a head alfo; Stean, Tin. Cornifh). A Tin pit. A miry head. (Carew).
Powdered. Powdered Ore. When a Lode is fpotted with Ore, or ftones of Ore, but in fo diffeminate a quantity and appearance as to be fcarce worth the charges of dreffing, they fay, "It is Powdered Ore, or Dredged Ore."
Pride—Of the Country. When Ore is found near the furface, at a level where it is rarely met with, and in great abundance and very rich; alfo, when a bunch of Ore is found out of a Lode like ftones fcattered in a quarry, they fay, "It is the Pride of the Country."
Pryan. (From Pryi, Clay, Cornifh). Pryan Ore, Pryan Tin, Pryan Lode; that which is productive of Copper Ore or Tin, but does not break in large folid ftones, only in grofs pebbles, or fandy with a mixture of clay.
Puppy. The fet or tier of pumps below the Lilly under-ground.
Purser. A perfon deputed to keep and adjuft the accompt-book, to receive the cofts, and difcharge the demands on the Mine; ufually, both treafurer and fecretary of a Mine.

Q

Quarey. When a Lode or Stratum breaks in large hard rocks, being jointed as it were, it is called a Qûarey Lode or Stratum, from its joints or Qûares.

 Quarts.

Quarts. A hard, opaque, and fometimes femi-tranfparent cryftalline ftony mafs, vulgarly called Spar, which it is not, being a chryftalline bafis. It is common in all our Lodes, fome being little elfe. It is very plenty on our barren heaths, and is ufeful only for hedging and paving the ftreets.

R

Rabban—Stone. A yellowifh dry ftone, refembling Goffan.

Rabble. An iron rake for ftirring and fkimming of Copper Ore in calcination and fmelting.

Rack. See Frame.

Raffain. Raf. Raffain Ore; poor Ore of no value.

Rag-Pump. A chain pump.

Rake, See Rabble. A true vein or Lode. (North of England).

Ramming-Bar. A beater. (North of England).

Red-Rabb. Red Killas.

Relief—Time. See Core and Day-Pair.

Renewing. See Tollur.

Rib—Of Ore. A leader, branch, or ftring of Ore.

Ridar. A fieve. (Cornifh). A Riddle. See Griddle.

Rid—up a Shaft. To clear it of the deads or attle fallen into it.

Rise—in the back. To work upwards towards the furface.

Rod—Shaft. An engine Shaft; becaufe of the ftraight Rods which go down in the Shaft, and are fixed to the piftons of the pumps.

Roof. See Back.

Roundhouse. The vortex or round of a whym or engine race if hedged about and covered, is called the Roundhoufe.

Roughs. Vulgo, Rows. See Crop.

Rôz. A wheel. Graver-Rôz, a wheel-barrow.

Run. To "run from a Bargain," is when a Pair or fet of men undertake a piece of work, and quit it before it is quite finifhed. "Run of the Lode," is the courfe or direction of it. "Run "of the Country," fee Country.

Running—Tackle. See Tackle, Axle-tree, and Brace.

S

Saller. Solarium, (low Latin) a garret or chamber. Soler, (Cornifh) a ground room, an entry, paffage, or chamber. Sol, is a foundation. A Saller, in a Mine, is a ftage or gallery of boards for men to ftand on and roll away broken ftuff in wheel-barrows—a Bunding, in Derbyfhire. There is alfo another kind of Saller in an Adit, being boards laid hollow on its bottom, by means of which air is conveyed under feet to the workmen; this is called the Adit Fang, in Derbyfhire. In a footway Shaft, the Saller is the floor for a ladder to reft upon.

Sample. The taking certain portions of Tin or Copper Ores to affay or try the value of by fire or water, they call, "Taking a Sample;" the perfon employed are named Samplers; and the bufinefs itfelf Sampling. See Ticketing.

Scal. A corruption of the word Scale. When a part of the wall or fide of a fiffure falls away, after the Lode has been digged and removed, they call it a Scal or Scale: fo if the fide of a quarry falls down in large flakes of ftone, it is called a Scal, or Scaling.

Scovan—Lode. Is a Tin Lode, only in contradiftinction to all other Lodes.

Scove. Tin-ftuff fo rich and pure as it rifes out of the Mine, that it has fcarce any need of being cleanfed by water.

Scoop. See Teem.

Scrowl. When a metallick Lode is interrupted and cut off by a Crofs-Goffan, it may fometimes be found again by the tendency of fome loofe ftones of the true Lode in the body of the Goffan; i. e. a Scrowl.

Seam. A Seam of Tin is a horfe load, viz. two fmall facks of black Tin. I believe it is borrowed from the German Mine term, Saume of Quickfilver, about 315 ℔ in two fmall barrels on a horfe. See Brown's Travels.

Searge. A fieve.

Serving. A Serving, is one or more hand-barrows full of Tin Ore ready for the burning-houfe or calciner, as it is lodged in the dry or vat for the next ferving or fupplying the furnace. Called, alfo, a Layer or Laying of Tin.

Set. A Set is the ground granted to a company of Adventurers. The taking of a Set, fignifies the having a grant of the ground or Mine. Sometimes it implies the deed or leafe by which they enjoy the premifes.

Set—a Price. To fet a price on a fhare or Dôl in a Mine, is this: when A, who owns a Dôl in a Mine, agrees to give B, another Adventurer in the fame Mine,

Mine, a price or ſum of money, on condition that B will ſet a price or value on ſuch or ſuch a Dôl (for inſtance, one-eighth part) if B accepts the money, he names a price, and ſo A is at his own option whether he will take B's Dôl at that price, or whether B ſhall take A's Dôl, and pay him the given price for it. Now this double advantage in favour of A, is in conſideration of the earneſt-money he gave B; ſo that let the Dôl be diſpoſed of either way, the earneſt-money is out of the queſtion, and belongs to B: on the other hand, A is obliged either to take B's mentioned Dôl, or elſe to let him have an equal Dôl at the price that B ſet on it; ſo that A has his choice of the agreement, and B contents himſelf with what A refuſes or declines.

Shaft. (Schact; ſee Agricola de Re Metallica). A groove or pit. All deep pits on a Mine, or on an Adit, are Shafts, provided they are ſunk down from graſs. Of thoſe there is the landing or working Shaft, where they bring up the work or Ore to the ſurface; but if it be worked by a horſe-engine or whym, it is called a Whim-Shaft; and where the water is drawn out of the Mine, it is indifferently named an Engine-Shaft, or the Rod-Shaft.

Shammel. A ſtage of boards uſed in old Coffins before Shafts were in common uſe. So they now call any ſtage of boards for ſhovelling of Ore or Deads upon, a Shammel. See Coffin.

Shed. A ſhade or ſhelter from the weather, under which the Cobbers cob the Ore.

Shelf. The looſe ſtones immediately over the faſt, or firm rocks. Shelf is diſtinguiſhed by looſe and firm Shelf; thoſe ſmall looſe ſtones that are under the earth, are looſe Shelf; thoſe which are larger and not ſo looſe, and juſt on the faſt, or firm rock, are the firm Shelf; and a double Shelf is where there are two ſuch Strata: ſo that the Miners are often deceived in Shoding, imagining they have but one Shelf to ſhode upon.

Shode. Perhaps from the Teutonick, Shutten, to pour forth. Shoding is the method of finding veins of Tin by digging ſmall pits in order to trace out the Lodes of Tin, by the ſcattering looſe ſtones and fragments that were diſperſed from them by the retiring waters of the deluge: thoſe looſe ſtones thus diſperſed, are Shode ſtones.

Shut—up a work. To diſcontinue the working a Mine. "A Shut of hard "ground," implies a ſtope or piece of denſe Stratum, that will probably be of ſhort continuance. Shutting or Shooting ground; ground which requires to be blown with gunpowder.

Shutting—of Attal. When a Gunnies is filled with Attal or Deads, and they want to have a paſſage through it, they thruſt in deal boards on every ſide of Durns or frames of timber, whereby they gain a paſſage through, which they ſecure with all imaginable ſpeed, as faſt as they can clear the Attal. Thoſe boards and Durns in the north of England, they call Groove-timbers and Stop-rods. See Durns and Laths.

Side-Adit. When an Adit is partly fallen in or choaked, and it is thought moſt adviſable to drive on the ſide of the choak, it is called a Side-Adit.

Sink. To ſink on the Lode or elſewhere, is to work in depth or deeper from the ſurface; or to ſink a deeper Dippa or Sumph in a Mine.

Skimpings. (From Scum or Skimming) In dreſſing ſtampt Tin in the kieve or vat, after it is tozed and packed, that is, ſtirred and ſettled, the beſt and heavieſt part precipitates to the bottom, and the lighteſt and poorer part lies uppermoſt, which is ſkimmed off and dreſſed again by itſelf, by the name of Skimpings Tin.

Skipsings. (ac idem, Stope).

Skit—Pump, is made like a ſhip's pump, and draws a little water at a ſmall depth.

Slab of Tin. A block of Tin.

Slide. A Slide is a Courſe-Flookan or Courſe-Goſſan, that either inclines faſter or in direct oppoſition to a metallick Lode, which it is wrongly ſuppoſed to elevate or depreſs.

Slime—Ore, or Slime Tin; the pulverized Mineral mixed with water in the ſtate of Slime or mud; or the ſuperfine particles of Ores which are carried down by the water in ſtamping or dreſſing until they ſettle in a pit of water called the Slime-Pit. In order to recover the Ore in this Slime, they dreſs it on a frame, whereby they waſh off Sludge earth and ſave the Ore.

Slocking-Stone. A tempting, inducing, or rich ſtone of Ore. Some Miners produce good ſtones of Ore, which induce the concerned to proceed, until they expend much money perhaps, and at laſt find the Mine good for nothing: ſo, likewiſe, there have been ſome inſtances of Miners, who have deceived their employers by bringing them Slocking-Stones ing-Stones from other Mines, pretending they were found in the Mine they worked in; the meaning of which impofition is obvious.

SLOTTERE. (Cornifh) Dirty, flovenly, muddy.

SLOVAN. See LOST-SLOVAN; vulgo Low-Slovan.

SMALL-MEN. Fairies. The Miners are fometimes perfuaded, that they hear a pick at work under-ground, as if fome invifible fpirit was at work underneath or near them. This noife, I fuppofe, proceeds from the running or falling of waters through the crevices and apertures of the earth. The opinion the Miners have of its being a good omen, encourages them to follow or work to it; fo that it has more than once occafioned a lucky difcovery.

SMALL ORE. Copper Ore dreffed to a fmall fize.

SMALL TIN. Tin dreffed from flime, &c. called Smaals. Alfo Floran Tin.

SOAPY HEADS. The joints of ftones, fmeared with a faponaceous flippery foil.

SOLE. See BOTTOMS.

SPAL. To fpal, is to break large folid rocks of Ore with fledges to a fmaller fize, in order to cull out the barren ftony parts.

SPAL. To fpaal. A fconce, amerciament, forfeiture. To deduct fo many ftems or days wages as a perfon has been wanting from his labour; or elfe to mulct him more than his wages, according to the ufage of that particular Mine.

SPALIARD. A Pickman; a working Tinner. See SPAL.

SPAR. A Mifnomer for Quartz and Cryftal in Cornwall. Sulphur and pure chalk united from the real fubftance, Spar.

SPEED. A quick, but wafteful way of dreffing, or rather coarfe cleanfing of Copper Ore, by an iron grate in a quick ftream of water.

SPEL. A lift, help, or turn; thus if two men are at any kind of work, and alternately change and relieve one the other, they call it "To give and take "a Spel," or Spel and Spel.

SPEND—the Ground. To break and work it away to prove a Mine.

SPILL and WEDGE. Mortices and wedges for locking or fixing large props of timber, which fupport a Mine, to the walls thereof, that they may hold firm in their places.

SPREADERS. Are pieces of timber that are placed athwart a Shaft, &c. which is likely to fall in, in order to keep it open and fafe, till they can board and fecure it.

SQUAT. Woodward calls it a Mineral; but in the Miner's fenfe of it, "The "Squat of the Lode," means a large Lode, or heap of the Lode in one place.

STAMPS—or Stamping-Mill. A mill worked by water for pounding and pulverizing Tin or Copper Ores; having large irons, called Stamp-Heads, fixed to pieces of wood (fee LIFTERS) which alternately rife and fall and break the ftones.

STAMPS-CAPTAIN. The fuperintendant dreffer at the ftamping mill.

STANDING-GROUND. Ground that will ftand firm and require no timber and boards to bind and fupport it.

STANNARY—Laws, Stannaries, and Stannary-Courts; are Laws, Precincts, Cuftoms, and Courts peculiar only to Tinners and Tin Mines.

STANNATORS. The upper houfe of convocation or parliament of Tinners, twenty-four in number, being chofen by the mayors and corporations of Launcefton, Loftwithiel, Truro, and Helftone, for the Stannaries or Precincts of Foymore, Blackmoor, Tywarnhayle, and Penwith and Kirrier. See ASSISTANTS and CONVOCATION.

STEM. A day's work. A double Stem, is to work fix hours extra.

STEMMYN. Ditto.

STEMPEL. A flant beam ufed in Tin Mines. Large pillars or pieces of timber placed in Mines to fupport them.

STENT. Rubble, loofe dead earth.

STILLEN. See ASTYLLEN.

STOPE. A Step. When a fumph or pit is funk down in a Lode, they break and work it away as it were in ftairs or fteps, one man following another, and breaking the ground, which manner of working in a fumph or any other part of a Mine, is called Stopeing; and that height or ftep which each man breaks, is called a Stope. Likewife, hewing away the Lode overhead, is "Stopeing "in the back."

STOWS. See AXLETREE.

STRAKE. See STREK.

STREAMERS, STREAMING, and STREAM-WORKS. Firft, the Tinners which work upon Stream Tin. Second, the Stream-Working. Third, the Stream-Works which are very different from Lode-Works. The firft implies Streaming upon the furface, the latter fuch Works as as are wrought in the bowels of the earth.

Strek. (A Stream, Cornifh) unde Strake. Strakes, are frames made of boards, fixed on or in the ground, where they wafh and drefs the fmall Ore in a little ftream of water; hence termed Straked Ore.

Strep. See Strek.

Strîk. (Active, fwift; Cornifh) To ftrîk or ftreeck down, or ftrike down; is to let a man down in a Shaft by the windlafs, and if he calls up to the men above-ground to ftreeck, they let him go farther down; if he fays, Hold, they ftop; and when he wants to afcend, he cries, Wind up. The phrafe of "Striking a Mine idle," is to difcontinue the working of her.

String. A fmall vein, rib, or branch of a Lode or vein.

Struck-out. When a Lode by any Flookan, or any other accidental interference, is interrupted or cut out, they fay alfo, "She is ftruck out," or, "She is loft."

Stul. (See Astel; Stul, a rafter or fyle; Cornifh). Stil, (Cornifh) a houfe beam.

Sucked—Stone. A honeycombed porous ftone.

Sumph. (Sumpff, Agricola) A pit funk down in the very bottom of the Mine, to cut or prove the Lode ftill deeper than before; and in order to ftope and dig it away if neceffary, and alfo to drive on the Lode in depth. The Sumph principally ferves as a bafon or refervoir, to collect the water of a Mine together, that it may be drawn out by an engine or machine.

Survey—or Outcry for fetting of Pitches upon Tribute in a Mine; or ground to fink, ftope, or drive by the fathom, &c. &c.

Sweep-Rods. See Flats, and Pokkers and Jetters.

T

Tackle or Takle. (Turn-tree, Derbyfhire) The Axle, Rope, Kibbals, &c. appertaining to a Shaft, called "The Running-Tackle."

Tails. The roughest refufe of ftampt Tin thrown behind the tail or end of the buddle, which are ftamped again with poor Tin-ftuff, in order to take out all the Tin remaining in them.

Takers, are thofe who take or farm a Mine, or a Pitch upon Tribute in a Mine of the Adventurers, for any limited time, agreeing to pay them a confideration in money or in kind; after the Tin or Ore is made faleable at the Taker's expence. "To take an end," is to contract for driving the end of an Adit or Drift for fo much ℘ fathom. "To take up an Adventure," is to engage in, or put on, a Mine affair.

Tamping a Hole. (Stemming a hole, North of England) When a hole is bored in the rock for blafting with gunpowder, they fill the upper part of it, upon the charge of powder, with clay and ftony matter rammed down very clofe and tight, which is Tamping the hole, and the clay and ftone is called the Tamping.

Tapping. See Charge.

Teary-Ground. Lode or Stratum that will break and tear up eafily, by a multiplicity of finufes or joints croffing each other. Speedy-Ground.

Teem. (To pour; Swift) To lade out water with bowls or fcoops in Stream works, or Dippas under-ground.

Ticketing. (See Sample and Assaying) The method for fale of Copper Ore, thus: on the appointed day each of the Copper buyers attends and produces a Ticket or written paper, in which is expreffed the price that he will give for the Ore; and the beft bidder has it.

Tide. Twelve hours. Two Tides, twenty-four hours.

Timberman. See Binder.

Tin. See Tin-stuff, Floran Tin, Grain Tin, &c.

Tin-stuff. Tin Ore; the Ore of Tin as it rifes out of the earth, is called Tin-ftuff, and not Ore, as the Mineral of other Metals is.

Tinners. All Cornifh Miners.

Toas. (Pafte; Toazer, Armoric, a kneading-trough) unde, to Toaz; that is, to fhake or Tofs the wet Tin to and fro in a kieve or vat with water, to cleanfe and drefs it.

Tol. (A hole, Cornifh) The bounder's part of the Tin-ftuff.

Tollur. (See Bounder) A man that infpects or fuperintends Tin Bounds; becaufe Bounds are defcribed and limited by holes cut in the graffy earth, which muft be repeated once every year, which they call Renewing.

Tomals. (Cornifh) A quantity, much, great heaps of any thing.

Tools. All hand implements for working a Mine, fuch as Picks, Gad, and Shovels.

TRACE. To trace the Lode, is the fame thing as backing of it; that is, to lay open the Bryle, and difcover the back of the Lode, by many pits, for feveral fathoms in length, eaft and weft.

TRAIN. Training the Lode. See TRACE. Where a Lode has been difcovered for fome length upon its back, ut fupra, it is called, "The Train of the Lode," and "The Run of the Lode."

TRELOOBING. A ftirring and working the Loobs or flimy earth of Tin, &c. in a flime-pit, that the mud may partly wafh off with the water, and the Ore fettle at bottom.

TRIBUTE. (A Cope, North of England) A confideration or fhare of the produce of a Mine either in money or kind, the latter being firft made merchantable, and then paid by the Takers or Tributors to the original Adventurers or owners, for the liberty granted to the Takers of enjoying the Mine, or a part thereof, called a Pitch, for a limited time.

TROIL. A Tinner's feaft or way of merriment, by eating and drinking; called alfo a Duggle.

TRUNK. A Strêk or ftrakes, with a very fmall ftream or dribble of water to wafh the flime of Tin or Copper Ore, whereby the lighter earthy parts are carried off with the water. The operation is called, "Trunking the flimes."

TURN-HOUSE. When a Drift is driven acrofs the country N. and S. to cut a Lode, they make a right angle from their Drift, and work on the Lode itfelf, which, as it is in a contrary direction to their paft Drift, they call Turning-houfe, in order to work on the courfe of the Lode.

TUT. Tut-bargain; i. e. by the lump: as when they undertake to perform a piece of work at a fixed price, prove how it may.

TYE. The fame as Strêk, but worked with a fmaller ftream of water. Tye or Ty, is a word made ufe of alfo in the ftannary of Blackmore, to fignify an Adit or drain.

TYER—or Tier of Pumps. A fet of pumps belonging to the engine, of which the lower pump or piece is called the Driggoe, but more frequently the Working-piece; the others have names appropriated to them, as the Tye or Adit-lift, the Rofe-lift, the Crown-lift, the Lilly, the Puppy, &c. each being a feparate Tier or Tyer.

V.

VAN. (From the French, Avant, foremoft). To make a Van, is to take a handful of the Ore or Tin-ftuff, and bruife, wafh, and cleanfe it on a fhovel; then by a peculiar motion of the fhovel, to fhake and throw forth upon the point of it almoft all the Ore that is freed from wafte. This operation being repeated, the Ore is collected and referved, and from thence they form an eftimate how many tons of Copper Ore, or how many hundred weight of Block Tin, may be produced out of one hundred facks of that work or ftuff of which the Van is made.

VATE or VAT. A fquare hollow place on the back of a calcining furnace, wherein they lay the next ferving of Tin Ore to dry before it is let down into the furnace, into which it paffes through a plug hole in the bottom of this Vate or Dry.

VINNEWED or VINNEY. (Ainfworth) Mouldy. Vinnewed Ore; Copper Ore that has a blue or green fpume, or efflorefcence upon it like verdigris.

UNDERGROUND-CAPTAIN. See GRASS-CAPTAIN.

UNDERSIZED. See DUMB'D.

UNHEAD A LODE. When a Lode is fractured or interrupted, fo as to be entirely interfected by a crofs vein, flide, &c. then it is faid to be Unheaded.

VOOGA. (Cornifh) Smoak. We alfo call a hollow cavern, either in the earth, or the Mines, or by the fretting of the fea, a Vooga; in the Mines, a Vooga-hole.

VOU-HOLE; from Vau, or Vauw. A natural cavity, hole, or chafm, in the earth or a Mine; ac id. Vooga. (A Shack, in Derbyfhire).

UPSTANDERS. Pieces of timber or boards which are fixed in the ground at a Shaft, to fupport the axletree, &c. See BRACE.

W

WASTREY. See ATTAL.

WATER-BARREL. A large barrel bound with iron hoops, which ferves to draw water out of a Mine.

WATER IN FORK. See FORCQUE.

WATERMEN. Thofe who are any way particularly employed about water under-ground; efpecially thofe who draw water at the Rag and Chain Pump.

WHEEL. An abbreviation of Water-wheel, implying a Water-engine.

Wheel-Pit. A very large but ſhallow pit that is ſunk in the ground, or at ſome depth under-ground, in order to erect a water-wheel and engine in it.

Whele. Id. Huel, or Wheal. See Huel.

Whym or Whim. A horſe engine. Sometimes its uſe is to draw water; but moſtly it is intended to wind or roll up the work out of a deep Mine, being wrought by horſes. An Engine, Derbyſhire.

Whym-Round. A Volt, (Johnſon). Engine-Race, North of England.

Whym-Shaft and Whym-Kibbal. See Shaft and Kibbal.

Whip. See page 179.

White Tin. Block Tin, or purified Tin, brought to its ultimate perfection by fire.

Wild Lead. See Mock Lead.

Windlass. See Axletree.

Winds. See Axletree, Little-Winds. The Turn, North of England.

Work. (From the Teutonick, Werke; a Mine). Work often ſignifies the Ore or deads, or other earth or ſtone, that is broken in a Mine, and brought up to graſs. This word often implies the Mine itſelf, as when they ſay, a Rich Work, or a Poor Work, inſtead of a Rich Mine, or a Poor Mine. A Tin Work. A Copper Work. They likewiſe term Copper ſmelting furnaces, Copper Works.

Working-Big. Is the ſpace of about two feet and a half wide, ſo that a man may have room enough under-ground in a Lode or in a Drift to uſe his Pick and other tools without breaking any of the contiguous Strata not of a veiny nature: hence they ſay, a Lode is a Working-big, that is, two feet and a half wide.

Z

Zighyr. (Slow, Corniſh) When a very ſmall ſlow ſtream of water iſſues through a cranny under-ground, it is ſaid to Zighyr or Sigger.

F I N I S.